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Program Requirements Document
for the
Human Research Facility

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Program Requirements Document

for the

Human Research Facility

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ACRONYMS AND ABBREVIATIONS

µs	microseconds
AC	Alternating Current
ADP	Acceptance Data Package
ANCP	Acoustics Noise Control Plan
ANSI	American National Standards Institute
APID	Application Process Identification
APM	Attached Pressurized Module
ARIS	Active Rack Isolation System
ASC	Aisle Stowage Container
ATV	Automated Transfer Vehicle
BIT	built-in-test
C&DH	Command & Data Handling
C&W	Caution and Warning
CAM	Centrifuge Accommodation Module
cc	cubic centimeters
CCB	Configuration Control Board
CCSDS	Consultative Committee for Space Data Systems
CI	Cargo Integration
CIL	Critical Items List
Cm	centimeter
CO_2	Carbon Dioxide
COF	Columbus Orbiting Facility
CoFR	Certification of Flight Readiness
COTS	Commercial/Off-The-Shelf
CUC	Computer Usage Control
dBA	Acoustic Decibel Level
DDCU	Direct Current -to-Direct Current Converter Unit
DC	Direct Current
DCR	Design Certification Review
DGCS	Display and Graphics Commonality Standards
DRD	Data Requirement Description
DRL	Data Requirements List
EEE	Electrical, Electronic, and Electromechanical
EIA	Electronics Industry Association

EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPCE	Electrical Power Consuming Equipment
EPS	Electrical Power System
ESA	European Space Agency
ESD	Electrostatic Discharge
EUE	Experiment Unique Equipment
EVA	Extravehicular Activity
EWACS	Emergency Warning and Caution System
EXPRESS	EXpedite the PRocessing of Experiments to the Space Station
FDS	Fire Detection System
FMEA	Failure Modes and Effects Analysis
FRD	Functional Requirements Document
FRR	Flight Readiness Review
FSS	Fluid System Servicer
GCAR	Government Certification Approval Report
GFCI	Ground Fault Circuit Interrupters
GIDEP	Government and Industry Data Exchange Program
GN_2	Gaseous Nitrogen
GPVP	Generic Payload Verification Plan
GSE	Ground Support Equipment
H	Halt
HDP	Hardware Development Plan
He	Helium
HRD	Hardware Requirements Documents
HRDL	High Rate Data Link
HRF	Human Research Facility
HRFM	High Rate Frame Multiplexer
Hz	Hertz
I/F	Interface
ICD	Interface Control Document
IDD	Interface Definition Document
IDD	Interface Definition Drawing
IDP	Integrated Data Pack
IEEE	Institute of Electrical and Electronic Engineers
IRE	Institute of Radio Engineers

ISIS	International Subrack Interface Standard
ISPR	International Standard Payload Rack
ISS	International Space Station
ITCS	Internal Thermal Control System
IVA	Intravehicular Activity
JEM	Japanese Experiment/Equipment Module
JIP	Joint Implementation Plan
JSC	Johnson Space Center
kHz	kiloHertz
KSC	Kennedy Space Center
LAN	Local Area Network
Lbm	pound mass
LED	Light Emitting Diode
LRDL	Low Rate Data Link
LSDS	Life Sciences Data System
LSE	Laboratory Support Equipment
MDM	Multiplexer/Demultiplexer Module
MDP	Maximum Design Pressure
MMCH/Y	Mean Maintenance Crew Hours per Year
MPLM	Mini Pressurized Logistics Module
MRDL	Medium Rate Data Link
ms	millisecond
MSFC	Marshall Space Flight Center (Huntsville, AL)
MTBF	Mean Time Between Failure
MTL	Moderate Temperature Loop
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NSTS	National Space Transportation System
NTSC	National Television Standards/System Committee
oct	Octave
ORU	Orbital Replacement Unit

ACRONYMS AND ABBREVIATIONS (Continued)

Pa	Pascal
PCS	Portable Computer System
PD	Payload Developer
PDS	Payload Data Set
PFE	Portable Fire Extinguisher
PFM	Pulse Frequency Modulation
PHTRS	Packaging, Handling, and Transportation Records
PIA	Payload Integration Agreement
PIRN	Payload Interface Revision Notice
PODF	Payload Operations Data File
PPC	Point-to-Point Communications
PRD	Program Requirements Document
Psi	Pounds Per Square Inch
PSRP	Payload Safety Review Panel
PU	Panel Unit
PUL	Portable Utility Light
PVP	Payload Verification Plan
QD	Quick Disconnect
QMS	Quality Management System
R&M	Reliability and Maintainability
RHA	Rack Handling Adapter
RIC	Rack Interface Controller
RMS	root-mean-square
RPC	Remote Power Controller
RPCM	Remote Power Controller Module
RSP	Resupply Stowage Platform
RSR	Resupply Stowage Rack
RT	Remote Terminal
RUP	Rack Utility Panel
SAR	System Acceptance Review
SDP	Software Development Plan
SE&I	Systems Engineering and Integration
SEE	Single Event Effect
SIR	Standard Interface Rack
SLPM	Standard Liter Per Minute
SOW	Statement of Work
SPIP	Station Program Implementation Plan

SPL	Sound Pressure Level
SRD	System Requirements Document
SSMB	Space Station Manned Base
SSP	Space Station Program
SSPC	Solid State Power Controller
STI	Science and Technical Information
STS	Space Transportation System
SWG	Science Working Group
TBC	To Be Confirmed
TBD	To Be Determined
TBR	To Be Resolved
TBE	Teledyne Brown Engineering
TCS	Thermal Control System
TIA	Telecommunications Industry Association
TM	Technical Memo
UIP	Utility Interface Panel
UOP	Utility Outlet Panel
USL	U. S. Laboratory
USOS	United States On-Orbit Segment
V	Volts
VC-S	Visibly Clean-Sensitive
VES	Vacuum Exhaust System
VRDS	Verification Requirement Data Sheet
Vrms	Volts (root-mean-square)
VRS	Vacuum Resource System
WSTF	White Sands Test Facility

HRF FLIGHT HARDWARE OVERVIEW

The HRF will be developed in several phases, or launch packages. Each launch package may be comprised of one or more integrated racks, any number of stowed and/or deployed instruments, or integrated experiments. The HRF Rack is a modified EXpedite the PRocessing of Experiments to Space Station (EXPRESS) rack. Launch package elements may be installed in active Standard Interface Rack drawers which are integrated into the HRF Rack, in stowage drawers integrated into the HRF Rack, or stowed in stowage trays or drawers external to the integrated HRF Rack. Each launch package is designed such that the integrated rack can be manifested for flight to orbit in a Mini Pressurized Logistics Module (MPLM) with some elements installed in the mid-deck of the Space Shuttle. Final integration of the launch packages will occur on-orbit.

1.0 PURPOSE

This Program Requirements Document (PRD) establishes a standard set of program requirements for design, fabrication, verification, safety, reliability, maintainability, quality assurance, and configuration management of Human Research Facility (HRF) flight hardware and software developed or modified for use on the International Space Station (ISS) Program. These requirements are set forth to ensure HRF flight hardware and software is produced in accordance with the requirements, processes, standards, and work instructions specified by Johnson Space Center (JSC) National Aeronautics and Space Administration (NASA) SA, SF, EA5, and NT divisions.

2.0 SCOPE

The requirements, processes defined in HRF plans, standards, and work instructions specified in this document are applicable to HRF integrated racks, HRF instruments, Experiment Unique Equipment (EUE), and HRF Laboratory Support Equipment (LSE) developed under the direction of the NASA JSC for the HRF Program. U.S. flight hardware and software developed at sites other than JSC shall meet the requirements specified in this PRD except as documented developer contracts. International Partner flight hardware and software using HRF Program services for integration into ISS shall meet the requirements, standards, and processes defined in this PRD except as documented in an approved Joint Implementation Plan (JIP).

3.0 CLASSIFICATION, FUNCTIONAL CRITICALITY, AND DESIGN LIFE

3.1 PAYLOAD CLASSIFICATION

Payloads shall have one assigned classification. Subrack payloads or hardware to be integrated into or become part of the facility may have a classification equal to or less than the facility classification. The Payload Developer shall include as an integral part of its Project Plan a recommended payload classification with associated rationale for each flight element. The ISS Payloads Office and Research Program Office will consider payload classification on a case-by-case basis and concur on the ultimate decision. Areas of consideration will include: the Payload Developers recommendation and rationale; the payload carrier and/or the complexity of the technical interfaces; the ISS technical and financial resources required; operations, and any unique issues associated with the payload.

3.1.1 Facility Class

Payloads in this class are those that have a direct physical interface with the ISS and a long utilization life is expected. Typical ISS payloads in this class would include recoverable free-flying spacecraft, externally attached payloads, and facility-class (rack/pallet-level) payloads. ISS life expectancy for Facility payloads is 10 years. Design approaches for this payload class shall allow full recovery from failures through in-flight servicing and maintenance.

3.1.2 Complex Subrack Class

Payloads in this class are those that nominally do not have a direct physical interface with the ISS, but that do require significant ISS resources to accomplish their research. Candidate payloads for this class are those that: support multiple investigations or a class of research (i.e., multi-user, multi-increment or reusable research hardware); require significant ISS technical resources (i.e., nominally occupy volume greater than one middeck locker or the equivalent); require funding resources for implementation in excess of $5M; or, challenge the capability of the ISS and Research Programs to adequately respond to a need to re-manifest. Design life for this payload class will satisfy the mission for the intended research. Design approaches may allow potential recovery from failures through in-flight servicing or return to ground.

3.1.3 Subrack Class

Payloads in this class are those that cost $5M or less. Design approaches may allow for in-flight servicing. If a failure occurs, the payload may be returned to the ground.

3.2 FUNCTIONAL CRITICALITY

Functional criticality for HRF flight systems shall be determined through Failure Modes and Effects Analysis (FMEA) defined in SSP 30234. Definitions for HRF flight systems criticality are as follows:

Category	Definition
1	Single failure point that could result in loss of ISS or loss of flight or ground personnel.
1R	Redundant items, all of which if failed, could result in loss of ISS or loss of flight or ground personnel.
1S	A single failure point of the system component designed to provide safety or protection capability against a potentially hazardous condition or event or a single failure point in a safety or hazard monitoring system that causes the system to fail to detect, or operate when needed during the existence of a hazardous condition that could lead to loss of flight or ground personnel (e.g., fire suppression, medical hardware, etc).
1SR	Redundant components designed to provide safety or protection capability against a potentially hazardous condition or event, all of which if failed could cause the system to fail to detect or operate when needed during the existence of a hazardous condition that could lead to loss of flight or ground personnel or the ISS; or redundant components within a safety or hazard monitoring system, all of which if failed could cause the system to fail to detect, or operate when needed during the existence of a hazardous condition that could lead to loss of flight or ground personnel or ISS.
1P	A single failure point which is protected by a safety device, whereby the proper functioning of the safety device, would prevent the hazardous consequences of the failed (protected) component.
2	Single failure point that could result in loss of critical mission support capability.
2R	Redundant items, all of which if failed, could result in loss of critical mission support capability.
3	All others.

HRF flight hardware function criticality must be approved by HRF program management and documented in the instrument unique SRD. Integrated rack criticality shall be documented in the integrated rack certification package.

4.0 DOCUMENTS

4.1 APPLICABLE DOCUMENTS

The following documentation with specific revision levels or dates listed below form the basis of program requirements specified in this document and are applicable to the extent specified herein.

DOCUMENT NUMBER	REVISION	TITLE
ANSI/ASQC Q 9001	1994	Quality Systems – Model for Quality Assurance in Design, Development, Production, Installation, and Servicing
JPG 8500.4	Rev. D 5/98	Engineer Drawing Quality Manual
JSC 28225	Basic 08/98	Space and Life Science Directorate Certification of Flight Readiness Implementation Plan
LS-10133-10	Rev. A 08/97	Documentation Preparation, Management, and Revision
LS-10133-12	Rev. B 08/97	Standards for Hardware Specific Documentation
LS-10133-18	Rev. A 08/97	Conducting Flight Equipment Reviews
LS-10133-24	Basic II 08/97	System Acceptance Review
LS-71001	Rev. A 11/96	Functional Requirements Document for the Human Research Facility
LS-71004	Draft 11/97	System Integration and Verification Plan for the HRF
LS-71005	Basic 02/97	HRF Configuration Management Plan
LS-71016	Baseline Change 1 05/98	HRF EMI/EMC Control Plan
LS-71020	Baseline 12/97	Software Development Plan for the Human Research Facility
LS-71020-1	Baseline 12/97	Software Configuration Management Plan for the Human Research Facility
LS-71030	Draft 10/97	Quality Assurance Plan for the Human Research Facility
LS-71128	Draft 10/97	System Audit Plan for the Human Research Facility

DOCUMENT NUMBER	REVISION	TITLE
MIL-STD-810	Rev. E	Environmental Test Methods and Engineering Guidelines
MIL-STD-1130	Rev. B 12/78	Connectors, Electrical, Solderless Wrapped
NASA-STD-6001	Basic 02/98	Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion
NHB 6000.1	Rev. D 09/90	Requirements for Packaging, Handling and Transportation For Aeronautical and Space Systems, Equipment, and Associated Components
NSTS/ISS 13830	Rev. C 07/98	Payload Safety Review and Data Submittal Requirements
SN-C-0005	Rev. C 02/89	Specification Contamination Control Requirements for the Shuttle Program
SP-T-0023	Rev. B 09/75	Environmental Acceptance Testing Specification
SSP 30223	Rev. F 11/94	Problem Reporting and corrective Action for the Space Station Program
SSP 30234	Rev. D 03/96	Instructions for Preparation of Failure Modes and Effects Analysis
SSP 30695	Rev. A 01/95	Acceptance Data Package Requirements Specification
SSP 50431	Draft 5/99	Space Station Program Requirements For Payloads
SSP 52005	Rev. B 12/98	Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures
SSP 57000	Rev. C 12/98	Pressurized Payloads Interface Requirements Document

4.2 REFERENCE DOCUMENTS

The following documents are referenced in generic requirements defined this document for HRF hardware and software design and verification. Revision dates of these documents applied to specific HRF end items shall be documented in end item unique requirements documents and ICDs.

DOCUMENT NUMBER	TITLE
683-10007	Fire Detection Assembly
ANSI/IEEE 802.3	Information Technology - Telecommunication and Information Exchange between Systems - Local and Metropolitan Area Networks - Specific Requirements
ANSI S1.11	Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters; ASA 65–1986 R (1993)
ANSI S1.4	Specification for Sound Level Meters Amendment S1.4A–1985 ASA 47 R (1994)
ANSI S12.12–1992	Engineering Method for the Determination of Sound Power Levels of Noise Sources using Sound Intensity ASA 104
ANSI S12.23–1989 (R1996)	Method for the Designation of Sound Power Emitted by Machinery and Equipment
ANSI S12.31–1990 (R1996)	Precision Methods for Determination of Sound Power Levels of Broad-band Noise Sources in Reverberation Rooms
ANSI S12.32–1990 (R1996)	Precision Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow-band Noise Sources in Reverberation Rooms
ANSI S12.33–1990	Engineering Methods for the Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room
ANSI S12.34–1988 (R1993)	Engineering Methods for the Determination Sound Power Levels of Noise Sources for Essentially Free-field Conditions over a Reflecting Plane
ANSI S12.35–1990 (R1996)	Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi-anechoic Rooms
ANSI S12.36–1990	Survey Methods for the Determination of Sound Power Levels of Noise Sources
CCSDS 301.0–B–2	Consultative Committee for Space Data Systems: Recommendation for Space Data Systems Standards; Time Code Format
CCSDS 701.0–B–2 Blue Book	Consultative Committee for Space Data Systems: Recommendation for Space Data Systems Standards; Advanced Orbiting Systems, Net-work and Data Links: Architecture Specification

DOCUMENT NUMBER	TITLE
D683-43631-1	EXPRESS Payload Software Interface Control Document - Human Research Facility
D684–10056–01	International Space Station Program, Prime Contractor Software Standards and Procedures Specification
EIA RS–170	Color Television Studio Facilities, Electrical Performance Standards
EIA/TIA–250	Electrical Performance for Television Transmission Systems
FED–STD–595	Colors Used in Government Procurement
ISO 9614–2	Acoustics – Determination of Sound Power Levels of Noise Sources using Sound Intensity – Part 2: Measuring by Scanning, (1996)
ISO/IEC–8802-3	Carrier Sense Multiple Access with Collision Detection – Access Method and Physical Specification
JSC 27199	End Item Specification for the International Space Station (ISS) Portable Utility Light
JSC 27260	Decal Process Document and Catalog
JSC 27337	Project Technical Requirements Specification (PTRS) Portable Computer System (PCS)
KHB 1700.7	Space Shuttle Payload Ground Safety Handbook
LS-71099	Hardware Requirements Document (HRD) Template for the Human Research Facility
MIL–C–27500	Cable, Power, Electrical and Cable Special Purpose, Electrical Shielded and Unshielded, General Specification for
MIL–STD–1553	Digital Time Division Command/Response Multiplex Data Bus Handbook
MIL-STD-1686	Electrostatic Discharge Control Program For Protection Of Electrical And Electronic Parts, Assemblies And Equipment (Excluding Electrically Initiated Explosive Devices)
MSFC–HDBK–527/ JSC 09604	Materials Selection List for Space Hardware Systems
MSFC-PLAN-2885 Annex 5	International Space Station Operations United States Payload Operations Data File Payload Display Implementation Plan
MSFC–SPEC–250	Protective Finishes For Space Vehicle Structures and Associated Flight Equipment, General Specification
MSFC–SPEC–522	Design Criteria for Controlling Stress Corrosion Cracking
MSFC–STD–275	Standard, Marking of Electrical Ground Support Equipment, Front Panels, and Rack Title Plates

DOCUMENT NUMBER	TITLE
MSFC-STD-531	High Voltage Design Criteria
NAS 5300.4 (3M)	Workmanship Standard for Surface Mount Technology
NASA TM 102179	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
NSTS 13830	Implementation Procedure for NSTS Payloads System Safety Requirements for Payloads Using the Space Transportation System
NSTS 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 1700.7B, ISS Addendum	Safety Policy and Requirements For Payloads Using the International Space Station
NSTS 18798	Interpretations of NSTS Payload Safety Requirements
NTC Report No. 7	Video Facility Testing Technical Performance Objectives
SSP 30233	Space Station Requirements for Materials and Processes
SSP 30237	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques
SSP 30240	Space Station Grounding Requirements
SSP 30242	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	Space Station Electrical Bonding Requirements
SSP 30257:004	Space Station Program Intravehicular Activity Restraints and Mobility Aids Standard Interface Control Document
SSP 30262:013	Space Station Program Smoke Detector Assembly Standard Interface Control Document
SSP 30312	Electrical, Electronic/Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan International Space Station Program
SSP 30426	Space Station External Contamination Control Requirements
SSP 30512	Space Station Ionizing Radiation Design Environment
SSP 30573	Space Station Program Fluid Procurement and Use Control Specification

DOCUMENT NUMBER	TITLE
SSP 30575	Space Station Interior and Exterior Operational Location Coding System
SSP 41000	System Specification for the International Space Station
SSP 41002	International Standard Payload Rack to NASA/ESA/NASDA Modules Interface Control Document (ICD)
SSP 41017	Rack to Mini Pressurized Logistics Module Interface Control Document (ICD) Part 1
SSP 41175-02	Software ICD Part 1 Station Management and Control to ISS Book 2 General Software Interface Requirements
SSP 50005	International Space Station Flight Crew Integration Standard
SSP 50007	Space Station Inventory Management System Label Specification
SSP 50008	International Space Station Interior Color Scheme
SSP 50184	Physical Media, Physical Signaling & Link-Level Protocol Specifications for Ensuring Interoperability of High Rate Data Link Stations on the International Space Station
SSP 50313	Display and Graphical Commonality Standard
SSP 50321	International Subrack Interface Standards (ISIS) Drawer Specifications (ISIS-02)
SSP 52050	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 57001	Pressurized Payloads Hardware Interface Control Document Template
SSP 57002	Payload Software Interface Control Document Template
SSP 57010	Pressurized Payloads Generic Payload Verification Plan
SSP 57020	Payload Accommodations Handbook
SSQ 21635	Connectors and Accessories, Electrical, Circular, Miniature, Intra-vehicular Activity (IVA)/Extravehicular Activity (EVA)/Robot Compatible, Space Quality, General Specification for
SSQ 21654	Cable, Single Fiber, Multimode, Space Quality, General Specification for Document
SSQ 21655	Cable, Electrical, MIL–STD–1553 Data Bus, Space Quality, General Specification for Document
SSQ 26678	Interconnection, MIL–STD–1553; Space Quality, General Specification

DOCUMENT NUMBER	TITLE
TIA/EIA-422	Electrical Characteristics of Voltage Digital Circuits

5.0 PROGRAM REQUIREMENTS

This section specifies requirements and processes for HRF hardware and software documentation, configuration management, reviews, and audits.

5.1 DOCUMENTATION REQUIREMENTS

Generic documentation products required for flight hardware/software development, verification, and certification are listed in Appendix A. Required documentation and reviews may vary depending on the classification and criticality of specific hardware and software end items. Documentation requirements shall be identified in an end item specific development plan and approved by the HRF Program. Hardware and software documentation and review requirements for an end item may be combined into a single development plan.

5.1.1 Documentation Standards

A. Hardware Specific Documentation

HRF hardware specific documentation shall be developed in accordance with HRF provided templates or with LS-10133-12, Standards for Hardware Specific Documentation when a HRF template is not provided.

B. Software Specific Documentation

HRF software specific documentation shall be developed in accordance with LS-71020, Software Development Plan for the Human Research Facility.

C. Engineering Drawings

Engineering drawings shall be developed in accordance with JPG 8500.4, Engineering Drawing Quality Manual.

D. HRF-to-ISS Interface Control Documents

Interface Control Documents (ICD) between HRF equipment and ISS systems shall be developed using ISS Payloads Office (OZ) provided standard ICD templates.

5.1.2 Documentation Management and Revisions

HRF documentation preparation, management, and revision shall be in accordance with LS-10133-10, Documentation Preparation, Management, and Revision.

5.2 CONFIGURATION MANAGEMENT

A formal configuration management system shall be implemented for the HRF Program and controlled by the HRF CCB.

5.2.1 Hardware Configuration Management

Hardware configuration management shall be implemented in accordance with LS-71005, HRF Configuration Management Plan.

5.2.2 Software Configuration Management

Software configuration management shall be implemented in accordance with LS-71020-1, Software Configuration Management Plan and Procedure for the Human Research Facility.

5.3 REVIEWS AND AUDITS

Required reviews may vary depending the classification and criticality of specific hardware and software end items. Required reviews shall be documented in hardware or software specific development plans and approved by the HRF Program.

5.3.1 System Requirements/Design Reviews

Equipment Requirements Reviews, Preliminary Design Reviews, and Critical Design Reviews for HRF unique hardware/software and reviews for Commercial/Off-the-Shelf (COTS) items shall be in accordance with LS-10133-18, Conducting Flight Equipment Reviews.

5.3.2 Design Certification Reviews

Design Certification Reviews (DCR) shall be conducted for qualification units prior to production of multiple flight units of the same design. A generic set of data products for DCRs are listed below. Specific data product requirements shall be documented in end item development plans.

- Hardware certification report
- User operations and maintenance documents
- Analysis reports (including those in which analysis was performed in place of a test to verify the readiness of an item)
- All test plans, test procedures
- Analysis and report of all testing results
- Test problem reports resolutions (pertaining to test)
- Government Certification Approval Report (GCAR)

5.3.3 System Acceptance Reviews

System Acceptance Reviews (SAR) shall be conducted in accordance with LS-10133-24, System Acceptance Review.

5.3.4 System Integration Reviews

System integration reviews shall be in accordance with LS-71004, System Integration and Verification Plan for the HRF.

5.3.5 Flight Readiness Reviews/Certification of Flight Readiness

Flight Readiness Reviews (FRR) and Certification of Flight Readiness (CoFR) for HRF systems shall be in accordance with JSC 28225, Space and Life Science Directorate Certification of Flight Readiness Implementation Plan.

5.3.6 Hardware/Software Requirements Audits

Requirements applicability and verification audits for new and reflown hardware and software shall be conducted as specified in LS-71128, System Audit Plan for the Human Research Facility.

5.4 QUALIFICATION AND ACCEPTANCE TESTING FOR HRF HARDWARE

5.4.1 Qualification and Acceptance Testing for HRF Hardware

The following qualification and acceptance tests are recommended by the HRF Program for flight hardware flown in a HRF integrated rack in the MPLM. The test levels listed in this section represent minimum levels and may differ for hardware flown in other launch environments. Required test shall be coordinated with JSC/NT and approved by the HRF program in end item development plans. All applicable tests shall be documented in the end item SRD. Test parameters may be adjusted to ensure flight hardware is not damaged during testing. Detailed test parameters shall be documented in end item test plans and procedures, coordinated with JSC/NT, and approved by the HRF Program.

Additional test may be required to verify compliance with the applicable requirements specified in section 6 of this document. These tests will be specified in end item Payload Verification Plans (PVP) and test plans.

5.4.1.1 Structural and Mechanical Requirements

5.4.1.1.1 Payload Mass

The LS-71014, Mass Properties Control Plan for the Human Research Facility shall address verification methodology for ensuring that the integrated rack and payloads comply with the center of gravity, mass, and moments of inertia requirements specified in section 6.1 of this document.

5.4.1.1.2 Sinusoidal Resonance Survey

HRF rack mounted instruments shall be subjected to a sinusoidal resonance survey to determine the fundamental resonance frequencies of the test article. The survey shall be conducted at a sweep rate of one octave per minute in each of three orthogonal axes from 5 to 200 Hz, one sweep up and down, with an input not to exceed 0.25 g zero to peak. The equipment under test shall have an accelerometer mounted at an accessible hard point on the test item near or on the center of gravity of the test article. The output of this response accelerometer shall be monitored and not allow the hardware to experience more than 0.5 g peak. The input acceleration level shall be monitored by an accelerometer mounted as close as possible to the test fixture/hardware interface.

5.4.1.1.3 Random Vibration Test

Random vibration testing is required for all HRF rack mounted hardware. Random vibration testing is not required for hardware packed in vibration damping materials such as foam, or for hardware launched in soft stowage containers. Each HRF instrument or EUE subjected to vibration testing shall be functionally tested before and after vibration testing. It is also preferred that the hardware be operating and functionally tested during vibration testing. An assessment of the impact of operating the hardware during vibration testing shall be conducted and recommendations presented. The pass-fail criteria for the functional test and the definition of the functional test will be equipment unique and shall be defined in the test plan and test procedure for each element.

It is recommended that the hardware be hard mounted to the vibration test fixture in order to achieve a one-to-one transfer of the vibration levels shown in the following paragraphs. If the individual hardware flight mounting configuration is expected to result in amplification of flight vibration levels above the test levels defined in the following paragraphs, a test program should be developed that verifies the survivability of the hardware.

Requirements for qualification vibration testing are defined in SSP 52005. Requirements for acceptance vibration testing are defined in SP-T-0023.

5.4.1.1.3.1 Qualification Random Vibration Test

Qualification Vibration Test (QVT) certifies the design for a number of launch cycles determined by the duration of the vibration test in each axis. QVT shall be conducted on dedicated qualification test hardware only. Spectral density and frequency of QVT vibration levels shall be equivalent expected flight levels. The duration of the QVT shall be four times the expected life time exposure to flight vibration, but not less than 60 sec per axis. Hardware may be certified for additional launch cycles by increasing vibration duration by 30 seconds in each axis for each additional launch cycle required. HRF requires a minimum duration of 120 seconds in each axis. The flight level vibrations for QVT are shown below.

Frequency	Level
20 Hz	0.005 g^2/Hz
20-70 Hz	+5 dB/octave
70-350 Hz	0.004 g^2/Hz
350-2000 Hz	-3.9 dB/octave
2000 Hz	0.002 g^2/Hz
Composite	4.4 g RMS

5.4.1.1.3.2 Qualification for Acceptance Random Vibration Test

Qualification For Acceptance Vibration Test (QAVT) determines the number of AVT that may be conducted on flight units. QAVT shall be conducted on dedicated qualification test hardware only. QAVT shall be conducted at 1.69 times Acceptance Random Vibration Test (AVT) vibration levels. QAVT vibration duration criteria shall be the AVT vibration duration times the number of AVT for which the hardware is to be qualified.

5.4.1.1.3.3 Acceptance Random Vibration Test

AVT is used to screen defects in workmanship that cannot be detected by inspection. If flight random vibration levels exceed minimum AVT vibration levels, AVT shall be conducted at the higher of the two levels specified by 1/1.69 times QVT levels or the minimum AVT levels shown below. Vibration duration shall be a minimum of 60 seconds in each of three axes. Minimum AVT levels are shown below.

Frequency	Level
20 Hz	0.010 g^2/Hz
20-80 Hz	+3 dB/octave
80-350 Hz	0.04 g^2/Hz
350-2000 Hz	-3 dB/octave
2000 Hz	0.007 g^2/Hz
Composite	6.1 g RMS

5.4.1.1.4 Shock Test

A shock test shall be performed on the qualification unit for all rack mounted hardware which will be subjected to ground handling shocks (not necessary if transport packaging will protect hardware from excessive shocks). A shock test shall be performed on the certification unit for all crew-worn hardware which will be subjected to potential shocks during usage by the crew. The shock test shall be a sawtooth wave form at a 20 g level for a duration of 11 milliseconds, three shocks in each direction of each of three orthogonal axes (a total of 18 shocks). The shock test shall be conducted in accordance with MIL-STD-810, Method 516.2, Procedure I. The hardware shall be functionally tested before and after each test direction of each axis, but not necessarily between shocks. To reduce set-up time, it is recommended that this test be performed between vibration test axes.

5.4.1.1.5 Bench Handling Test

A bench handling test shall be performed on the qualification unit for all stowed hardware. The bench handling test shall be conducted in accordance with MIL-STD-810, Section 516.4, I-3.6, Procedure 4 or 6 with the following modifications: Test conditions of 26 drops altered to two (2) drops. Surfaces, corners, edges shall be identified in the test procedure.

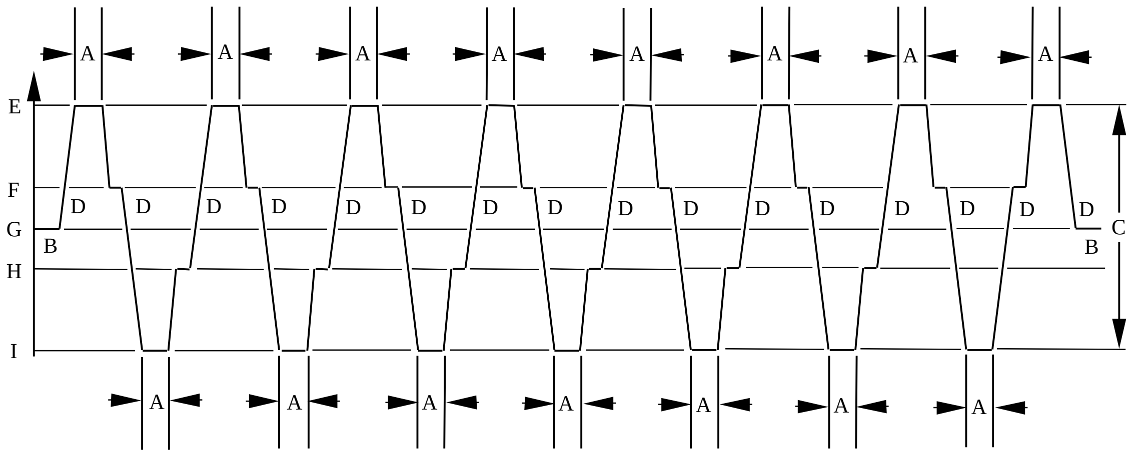
5.4.1.1.6 Thermal Cycle Test

HRF payloads undergoing thermal cycle testing shall be functionally tested at each stable temperature and during transitions. The pass-fail criteria for the functional test and the definition of the functional test will be equipment unique and shall be defined in the test plan and test procedure. Functional tests shall be conducted on end items prior to, during, and after environmental exposure.

5.4.1.1.6.1 Qualification Thermal Cycle Test

Qualification thermal cycle test shall be conducted on qualification units only. The test shall be conducted over a temperature range of 61.1 ^{o}C (110 ^{o}F) centered around the normal operating temperature as defined in the individual test plans. The qualification thermal test shall consist of seven and one half cycles. One cycle is defined as the starting time from normal operating temperature increasing to the maximum high temperature, decreasing to the maximum low temperature and then returning to the normal operating temperature. The hardware will be functionally tested during transitions, at the highest and lowest temperature extremes, consistent with the defined operating temperature range. If the hardware operating temperature range is less than the temperature extremes of the test, the hardware shall not be operated or tested until the test temperature is within the design operating temperature of the hardware. The specific profile shall be defined in the individual test plans.

Figure 5.4.1.1.6.1-1 shows the test profile for qualification thermal cycling. The complete test is seven and one-half cycles with one hour soaks at each extreme.



NOTES:

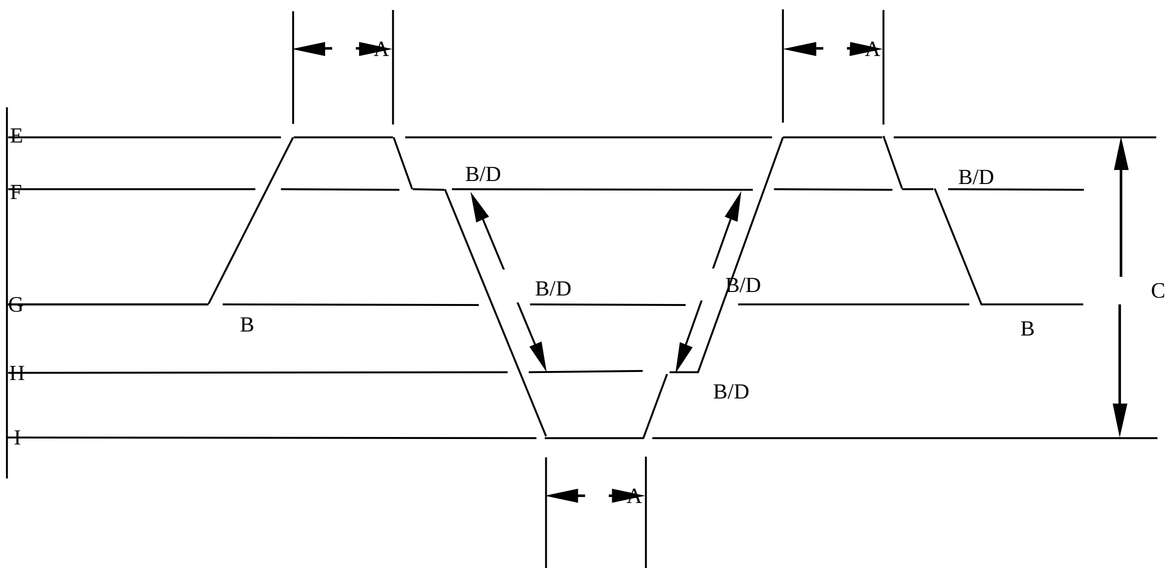
1. A = Time to stabilize equipment temperature plus 1-hour
2. B = Functional tests to be performed as shown.
3. C = Control temperature range between high and low acceptance test
4. D = Simplified functional test (optional). Rate of temperature change temperature transition shall not be less the 0.55°C (1°F)/min. nor greater than 2.22°C (4°F)/min.
5. E = Median operational temperature plus 30.56°C (55°F).
6. F = Maximum operational temperature.
7. G = Median operational temperature.
8. H = Minimum operational temperature.
9. I = Median operational temperature minus 30.56°C (55°F).

Figure 5.4.1.1.6.1-1. Qualification Thermal Cycling

5.4.1.1.6.2 Acceptance Thermal Cycle Test

An acceptance thermal cycle test shall be performed on all flight and flight alternate hardware. The acceptance thermal cycle shall be conducted over a temperature range of a 55.6 ^{o}C (100 ^{o}F) centered around the hardware normal operating temperature as defined in the test plan. The hardware shall be functionally tested before and after the temperature test, at each transition, and at each stable temperature. The hardware shall not be functionally tested at temperatures in excess of the defined operating temperature range.

Figure 5.4.1.1.6.2-1 shows the test profile for acceptance thermal cycling. The complete test is one and one-half cycles with one hour soaks at each extreme.



NOTES:

1. A = Time to stabilize equipment temperature plus 1-hour
2. B = Functional tests to be performed as shown.
3. C = Control temperature range between high and low acceptance test shall be a minimum of 55.56°C (100°F). Contractor is to specify tolerances on temperature periods.
4. D = Simplified functional test. Rate of temperature change during transition shall not be less the 0.55°C (1°F)/min. nor greater than 2.22°C (4°F)
5. E = Median operational temperature plus 27.78°C (50°F).
6. F = Maximum operational temperature.
7. G = Median operational temperature.
8. H = Minimum operational temperature.
9. I = Median operational temperature minus 27.78°C (50°F).

Figure 5.4.1.1.6.2-1. Acceptance Thermal Cycling

5.4.1.1.7 Acoustic Noise Surveys and Tests

The LS-71011, Acoustic Noise Control and Analysis Plan for Human Research Facility Payloads and Racks shall address verification methodology for ensuring that each payload and the integrated rack meet the acoustic requirements as defined in paragraph 6.4.3.3.

5.4.1.1.8 Flammability Tests

Payload materials shall be nonflammable or self-extinguishing per the test criteria of NASA-STD-6001, Test 1, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion. The material shall be evaluated in the worst-case use environment at the worst-case use configuration. When the use of nonflammable material is not possible, a Material Usage Agreement (MUA) or equivalent shall be submitted to the cognizant NASA center for disposition. If test data does not exist for a material, the experimenter may be asked to provide samples (NASA-STD-6001, Chapter 4) to a NASA certified test facility Marshall Space Flight Center (MSFC) or White Sands Test Facility (WSTF) for flammability testing.

Materials transported or operated in the orbiter cabin, or operated in the ISS air lock during Extravehicular Activity (EVA) preparations, shall be tested and evaluated for flammability in the worst-case use environment of 30-percent oxygen and 10.2 psia. Materials used in all other habitable areas shall be tested and evaluated in the worst-case use environment of 24.1-percent oxygen and 15.2 psia.

5.4.1.1.9 Off gassing (Toxicity)

All flight hardware located in habitable areas shall be subjected to test and meet the toxicity off gassing acceptance requirements of NASA-STD-6001, Test 7.

5.4.1.1.10 Electrical, Electronic, and Electromechanical (EEE) Screening Tests

To the extent practical, COTS and modified COTS must meet the EEE requirements to assure the hardware/design compliance to the EEE part selection criteria for the proposed applications and corresponding criticality. This includes a risk assessment, electrical stress analysis, and data delivery on information such as designed/as-built EEE parts, list, construction history, Government and Industry Data Exchange Program (GIDEP) Alerts, part obsolescence, radiation susceptibility, and/or prior history.

Where no alternative is available, nonmilitary parts, components and subassemblies may be used, but screening of these items shall be accomplished through burn-in. Screening shall be completed (100%) on all flight hardware (units).

Burn in may be accomplished at the component or assembly level. Burn-in shall be 72 hours continuously at room ambient temperature while functioning and 96 hours continuously at a specified controlled temperature while functioning.

Controlled temperature is defined as 15 °C below the maximum rating of the device with the lowest temperature rating in the article under test.

5.4.1.1.11 Safety Critical Structure Verification

5.4.1.1.11.1 Safety Critical Structure Dimensional Check

All HRF flight hardware structural elements identified as safety critical structures shall be verified to be in accordance with the final design drawing dimensional requirements. The EXPRESS Rack verification will be provided by the supplier.

5.4.1.1.11.2 Safety Critical Structure Material Certification

All structural elements that are identified as safety critical structures of each of the flight units shall have the components used in those safety critical structures certified to be fabricated from the materials and alloys identified in the final design drawings, and to be fabricated from materials approved by NASA-JSC.

5.4.1.2 Electrical Requirements

5.4.1.2.1 EMI/EMC Surveys and Tests

The LS-71016, HRF EMI/EMC Control Plan shall address the methodology for ensuring that each payload and the integrated rack meet the radiated and conducted emissions and susceptibility requirements as defined in Section 6.0.

5.5 SYSTEM INTEGRATION AND VERIFICATION REQUIREMENTS

The verification plans defined in this section shall be coordinated with JSC/NT and approved by the HRF Program prior to end item testing.

5.5.1 HRF System Integration and Verification

HRF hardware and software integration and verification for flight racks shall be in accordance with LS-71004, System Integration and Verification Plan for the Human Research Facility.

5.5.2 HRF Integrated Rack Verification Requirements

Generic requirements for integrated racks for the ISS Program are contained in SSP 57010, Pressurized Payloads Generic Payload Verification Plan. Detailed verification requirements for HRF integrated racks shall be documented in HRF integrated rack unique Payload Verification Plans (PVP) in accordance with the requirements applicability and exceptions specified in the corresponding HRF integrated rack ICD.

5.5.3 HRF Instrument and EUE Verification Requirements

Applicability of verification requirements for HRF instruments and EUE shall be specified in the HRF instrument or EUE unique SRD verification matrix. Detailed verification requirements for instruments or EUE shall be specified in instrument and EUE unique PVP. The process for development of these plans is defined in the LS-71004, Systems Integration and Verification Plan for the Human Research Facility, paragraph 4.0.

6.0 SYSTEM INTERFACE AND DESIGN REQUIREMENTS

The requirements in this section shall be used by HRF instrument developers in the development of an instrument HRD or SRD. HRD and SRD are equivalent documents in the HRF Program. These requirements are applicable in all ISS modules unless specified otherwise. Launch and landing related requirements are defined for Standard Interface Rack (SIR) drawers mounted equipment in HRF racks flown in the MPLM.

Section 6.1 is the set of ISS requirements generically applicable to HRF empty racks. Specific applicability of these requirements is documented in HRF rack Prime Item Development Specifications (PIDS) and form the contractual basis of HRF empty rack design.

Section 6.2 contains the set of ISS design and HRF rack interface requirements generically applicable to instruments that require HRF rack interfaces and resources to perform primary operations.

Section 6.3 provides ISS design requirements generically applicable to instruments that do not require HRF rack interfaces or resources to perform primary operations. Instruments with data storage capabilities that connect to HRF rack interfaces only for data transfer purposes should use section 6.3. Interface requirements for rack independent instruments are not contained in section 6.3, but will be documented in instrument SRD with the assistance of the HRF Systems Engineering and Integration (SE&I) group on an individual basis for each instrument.

Section 6.4 contains human factors requirements generically applied to all payload hardware by the ISS program. Instrument developers must document Section 6.4 requirement applicability in all instrument SRD.

Functional requirements for HRF hardware are not contained in this document. Functional requirements for specific hardware elements of HRF are contained in the LS-71001, Functional Requirements Document (FRD) for the Human Research Facility developed by the Science Working Group (SWG). Functional requirements for hardware items other than those documented in the FRD will be specified by the customer.

The process for developing an instrument SRD is as follows:

INSTRUMENTS USING SECTION 6.2

1. Obtain a copy of the LS-71099 SRD Template available through the Science and Technical Information (STI) Center/JSC Building 36 or the HRF Program.

2. Document instrument design descriptions and operational scenarios as specified in the SRD template.

3. Follow the instructions in LS-71099 to document the applicability of, or exceptions to, the requirements of section 6.2 and 6.4 of this document in the applicability matrices of the instrument SRD. The HRF SE&I group will assist instrument developers in the interpretation of requirements upon request.

4. Add instrument unique functional requirements and related verification from the LS-71001 Functional Requirements Document (FRD), if applicable, or from other document sources as specified by the customer. If performance requirements are from documents other than the FRD, add related verification requirements.

5. Submit the draft version of the instrument SRD to the HRF SE&I group. HRF SE&I will review requirement applicability based on instrument design descriptions and operational scenarios provided by the instrument developer.

6. SE&I will return the SRD to the instrument developer for processing through the appropriate document quality management system and approval by the HRF program.

<u>INSTRUMENTS USING SECTION 6.3</u>

1. Obtain a copy of the LS-71099 SRD Template available through the STI Center/JSC Building 36 or the HRF Program.

2. Document instrument design descriptions and operational scenarios as specified in the SRD template.

3. Follow the instructions in LS-71099 to document the applicability of, or exceptions to, the requirements of section 6.3 and 6.4 of this document in the applicability matrices of the instrument SRD. The HRF SE&I group will assist instrument developers in the interpretation of requirements upon request as well the development of interface requirements unique to the instrument design.

4. Add instrument unique interface requirements in the section specified in the SRD template. HRF SE&I will assist the instrument developer in the development and documentation of interface requirements and related verification criteria based on instrument design.

5. Add instrument unique functional requirements and related verification from the LS-71001 Functional Requirements Document (FRD) for the Human Research Facility, if applicable, or from other document sources as specified by the customer. If performance requirements are from documents other than the FRD, add related verification requirements.

6. Submit the draft version of the instrument SRD to the HRF SE&I group. HRF SE&I will review requirement applicability based on instrument design descriptions and operational scenarios provided by the instrument developer.

7. SE&I will return the SRD to the instrument developer for processing through the appropriate document quality management system and approval by the HRF program.

6.1 HRF RACK INTERFACE AND DESIGN REQUIREMENTS

This section contains the subset of SSP 57000 interface and design requirements generically applicable to HRF non-integrated racks. Requirements for MPLM electrical, Utility Outlet Panel (UOP), low temperature loop, pressurized gas (other than nitrogen), and Active Rack Isolation System (ARIS) interfaces are not included in this document.

Note: For configuration management purposes, requirement text defined in SSP 57000 is documented here verbatim, with one exception. Paragraph, figure and table numbers specified in SSP 57000 requirement text that are contained in this document have been changed to conform to the numbering structure of this document. No corrections to spelling, punctuation, first occurrence or use of acronyms have been made.

6.1.1 Structural/Mechanical

6.1.1.1 GSE Interfaces

A. HRF racks shall interface to the Kennedy Space Center (KSC) GSE Rack Insertion Device in accordance with SSP 41017 Part 1, paragraph 3.2.1.1.2 Static Envelope, 3.2.1.4.3 Interface Loads, and SSP 41017 Part 2, paragraph 3.3.2 Upper Attachment Interfaces and 3.3.3 Ground Handling Attachment Interfaces. **[SSP 57000C, paragraph 3.1.1.1.A]**

B. HRF racks shall interface to Rack Shipping Containers in accordance with the Teledyne Brown Engineering (TBE) as-built drawing 220G07500. **[SSP 57000C, paragraph 3.1.1.1.B]**

C. HRF racks shall interface to Rack Handling Adapters (RHA) in accordance with the following TBE as-built drawings: 220G07455 Upper Structure, 220G07470 MSFC Lower Structure, and 220G07475 KSC Lower Structure. **[SSP 57000C, paragraph 3.1.1.1.C]**

D. HRF racks shall be limited to ground transportation accelerations of 80% of flight accelerations defined by SSP 41017 Part 1, paragraph 3.2.1.4.2. **[SSP 57000C, paragraph 3.1.1.1.D]**

6.1.1.2 MPLM Interfaces

A. HRF racks shall interface to the MPLM structural attach points in accordance with SSP 41017 Part 2, paragraph 3.1.1. **[SSP 57000C, paragraph 3.1.1.2.A]**

B. HRF racks shall maintain positive margins of safety for MPLM depress rates of 890 Pa/second (7.75 psi/minute) and repress rates of 800 Pa/second (6.96 psi/minute). **[SSP 57000C, paragraph 3.1.1.2.B]**

C. HRF racks shall be limited to producing interface attach point loads less than or equal to those identified by SSP 41017 Part 1, paragraph 3.2.1.4.3, based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2 with a full complement of generic 4 panel unit Standard Interface Rack (SIR) drawer payloads. **[SSP 57000C, paragraph 3.1.1.2.E]**

6.1.1.3 Loads Requirements

A. HRF racks shall provide positive margins of safety for launch and landing loading conditions in the MPLM based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2 with a full complement of generic 4 panel unit SIR drawer payloads. **[SSP 57000C, paragraph 3.1.1.3.A]**

B. HRF racks shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction with a full complement of generic 4 panel unit SIR drawer payloads. **[SSP 57000C, paragraph 3.1.1.3.B]**

C. Rack Utility Panel (RUP) umbilicals shall be restrained during launch and landing to prevent damage to loose connectors from loads and vibration. **[SSP 57000C, paragraph 3.1.1.3.C]**

D. HRF rack equipment shall provide positive margins of safety when exposed to the crew-induced loads defined in Table 6.1.1.3–1, Crew-Induced Loads. **[SSP 57000C, paragraph 3.1.1.3.D]**

TABLE 6.1.1.3–1. CREW-INDUCED LOADS

CREW SYSTEM OR STRUCTURE	TYPE OF LOAD	LOAD	DIRECTION OF LOAD
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N-M (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf), limit	Any direction
Cabinets and any normally exposed equipment	Concentrated load applied by flat round surface with an area of (0.093 m^2) (1 ft^2)	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

[SSP 57000C, TABLE 3.1.1.3-1]

E. For design and qualification purposes, components mounted to U.S. International Standard Payload Rack (ISPR) posts shall maintain positive margins of safety for the MPLM ascent random vibration environment as defined in Table 6.1.1.3–2, “Random Vibration Criteria for U.S. ISPR Post-Mounted Equipment in the MPLM.” **[SSP 57000C, paragraph 3.1.1.3.E]**

TABLE 6.1.1.3-2. RANDOM VIBRATION CRITERIA FOR U.S. ISPR POST-MOUNTED EQUIPMENT IN THE MPLM

FREQUENCY	LEVEL
20 Hz	0.005 g^2/Hz
20-70 Hz	+5.0 dB/oct
70-200 Hz	0.04 g^2/Hz
200-2000 Hz	-3.9 dB/oct
2000 Hz	0.002 g^2/Hz
Composite	4.4 grms

Note: Criteria is the same for all directions (X, Y, Z)

[SSP 57000C, TABLE 3.1.1.3-2]

F. Components mounted to the ISPRs shall maintain positive margins of safety for the launch and landing conditions in the MPLM. For early design, the acceleration environment defined in Table 6.1.1.3–3, “Payload ISPR Mounted Equipment Load Factors (Equipment Frequency 35 Hz)” will be used. These load factors will be superseded by load factors obtained through ISS-performed Coupled Loads Analysis as described in SSP 52005. **[SSP 57000C, paragraph 3.1.1.3.F]**

TABLE 6.1.1.3-3. PAYLOAD ISPR MOUNTED EQUIPMENT LOAD FACTORS (EQUIPMENT FREQUENCY 35 MHz)

Liftoff (g)	**X** ±7.7	**Y** ±11.6	**Z** ±9.9
Landing (g)	X ±5.4	Y ±7.7	Z ±8.8

Note: Load factors apply concurrently in all possible combinations for each event and are shown in the rack coordinate system.

[SSP 57000C, TABLE 3.1.1.3-3]

6.1.1.4 Rack Requirements

A. HRF racks with a full complement of generic 4 panel unit SIR drawer payloads shall be limited to 804.2 kg (1773 lbs) for launch and landing in the MPLM and for ground and on-orbit operations. **[SSP 57000C, paragraph 3.1.1.4.A]**

B. HRF racks shall maintain positive margins of safety for the on-orbit depress/repress rates identified in SSP 41002 paragraph 3.1.7.2.1. **[SSP 57000C, paragraph 3.1.1.4.B]**

C. The HRF rack and kneebrace shall have a modal frequency in accordance with SSP 52005 paragraph 5.7, second paragraph for launch and landing, based on rigidly mounting the HRF rack in the launch configuration. **[SSP 57000C, paragraph 3.1.1.4.C]**

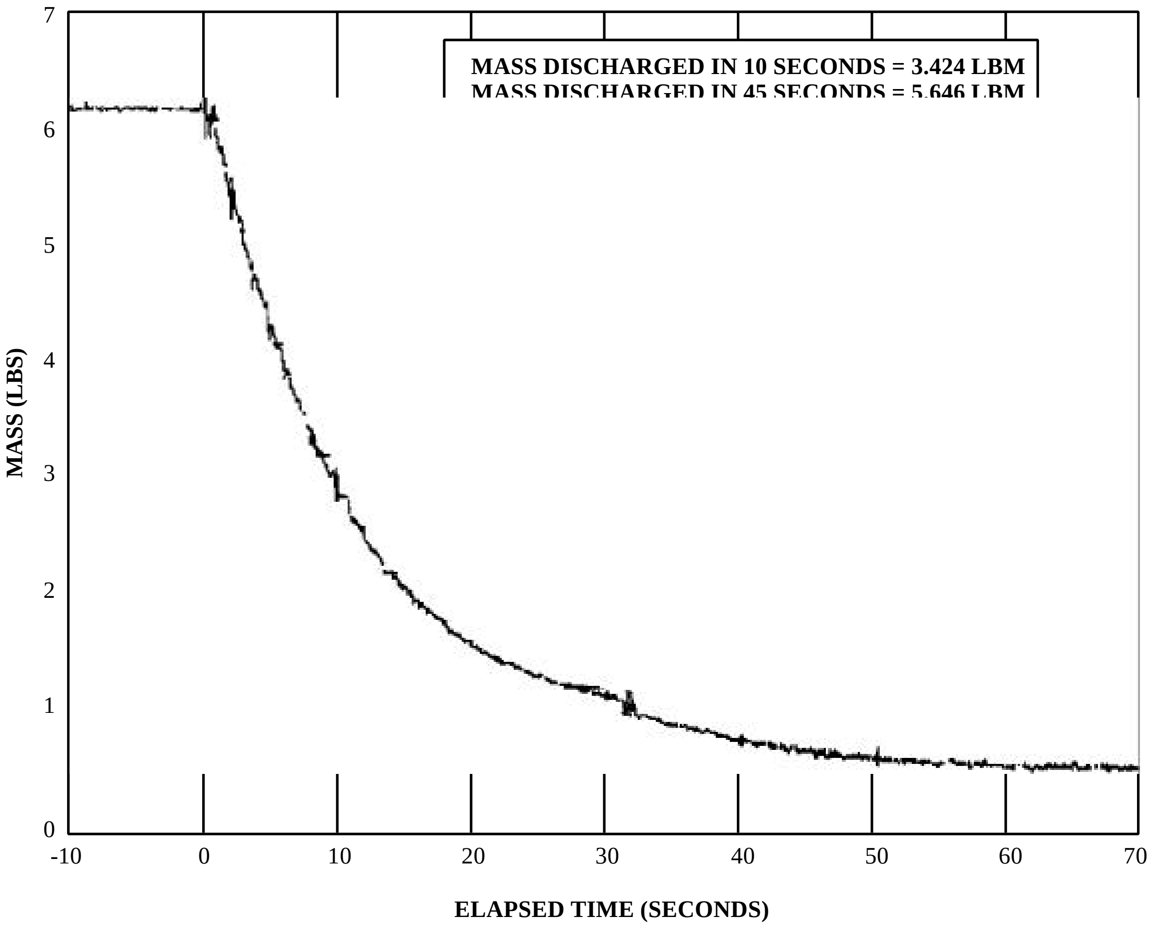
D. Equipment mounted directly to the rack will have a modal frequency goal of 35 (hertz) Hz for launch and landing, based on rigidly mounting the component at the component to rack interface. **[SSP 57000C, paragraph 3.1.1.4.D]**

E. HRF racks shall comply with the keepout zone for rack pivot mechanism as defined in SSP 41017 Part 1, paragraph 3.2.1.1.2. **[SSP 57000C, paragraph 3.1.1.4.E]**

F. HRF racks with a full complement of generic 4 panel unit SIR drawer payloads shall be capable of rotating a minimum of 80 degrees about the pivot point for on-orbit installation, removal, and maintenance functions. **[SSP 57000C, paragraph 3.1.1.4.I]**

G. Permanent HRF rack protrusions shall be limited to the rack static envelope defined in SSP 41017 Part 1, paragraph 3.2.1.1.2 Static Envelope. **[SSP 57000C, paragraph 3.1.1.4.J]**

H. HRF racks and rack equipment that have Portable Fire Extinguisher (PFE) access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 6.1.1.4–1. **[SSP 57000C, paragraph 3.1.1.4.K]**



[SSP 57000C, FIGURE 3.1.1.4–1]

Figure 6.1.1.4–1. Manual Fire Suppression System Performance Characteristics at the Rack I/F

I. HRF racks requiring rotation shall use the rack and crew restraints identified in SSP 30257:004 (for example, the 14 inch fixed length tether and the 71 inch adjustable length tether) to secure the rack in these rotated positions for payload operations and maintenance. **[SSP 57000C, paragraph 3.1.1.4.L]**

6.1.1.5 Safety Critical Structures Requirements

HRF racks shall be designed in accordance with the requirements specified in SSP 52005. **[SSP 57000C, paragraph 3.1.1.5.A]**

6.1.1.6 Connector and Umbilical Physical Mate

6.1.1.6.1 Connector Physical Mate

HRF racks shall physically mate with the Utility Interface Panel (UIP) and Fluid Services connectors intended to be used by the payload as listed in Table 6.1.1.6–1. **[SSP 57000C, paragraph 3.1.1.6.1]**

TABLE 6.1.1.6–1. MODULE CONNECTORS

	Module Connector	Module Part Number	Resource
A	J1	NATC07T25LN3SN	Main Power
B	J2	NATC07T25LN3SA	Essential/Auxiliary Power
C	J3	NATC07T15N35SN	1553 Bus A
D	J4	NATC07T15N35SA	1553 Bus B
E	J7	NATC07T13N4SN	HRDL
F	J16	NATC07T15N97SB	Optical Video
G	J43	NATC07T13N35SA	FDS/Power Maintenance
H	J45	NATC07T11N35SC	EWACS
I	J46	NATC07T11N35SA	LAN-1
J	J47	NATC07T11N35SB	LAN-2
K	J77	NATC07T13N35SB	Electrical Video
L	TCS Mod	683-16348, male, Category 6, Keying B	TCS Mod Supply
M	TCS Mod	683-16348, male, Category 6, Keying C	TCS Mod Return
N	TCS Low	683-16348, male, Category 6, Keying B	TCS Low Supply
O	TCS Low	683-16348, male, Category 6, Keying C	TCS Low Return
P	GN_2	683-16348-352	GN_2
Q	Vacuum Exhaust	683-16348, male, Category 3, Keying B	Vacuum Exhaust
R	Vacuum Resource	683-16348, male, Category 3, Keying A	Vacuum Resource
S	Ar	683-16348, male, Category 8, Keying C	AR
T	He	683-16348, male, Category 8, Keying E	HE
U	CO_2	683-16348, male, Category 8, Keying D	CO_2
V	Potable Water	683-16348, male, Category 7, Keying D	Potable Water
W	Fluid System Servicer	per Dwg 683-16348, male, 0.50 QD, Universal (no-keying)	Fluid System Servicer
X	J3	NATC00T15N97SN	Power/1553 Bus
Y	J4	NATC00T15N97SN	Power/1553 Bus
Z	J4	NATC00T15N97SA	Power/Ethernet

Notes: 1. Integrated rack connector part numbers are listed in the appropriate sections of SSP 57001.
2. UOP connector architecture is specified in SSP 57001, paragraph 3.2.1.2.

[SSP 57000C, TABLE 3.1.1.6.1–1]

6.1.1.6.2 Umbilical Physical Mate

HRF racks shall provide a Rack Utility Panel and umbilicals that allow connection of rack utilities from the rack to the standoff Utility Interface Panel defined in SSP 41002, Figure 3.2.2-1 and the appropriate Utility Interface Panel connector layout defined in SSP 41002 Figures 3.3-1 through 3.3-5. **[SSP 57000C, paragraph 3.1.1.6.2]**

6.1.1.7 Microgravity

Microgravity disturbances must be determined at the integrated rack level for each launch package.

6.1.2 <u>Electrical Interface Requirements</u>

Electrical power characteristics are specified in this section for Interface B. Interface B is defined as the ISS Electrical Power System (EPS) output at the UIP J1 and J2 connectors. For purposes of this specification, compatibility is defined as operating without producing an unsafe condition or one that could result in damage to ISS equipment or payload hardware.

6.1.2.1 Steady-State Voltage Characteristics

The HRF rack shall operate and be compatible with the steady-state voltage limits of 116 to 126 Vdc. **[SSP 57000C, paragraph 3.2.1.1.1]**

6.1.2.2 Ripple Voltage Characteristics

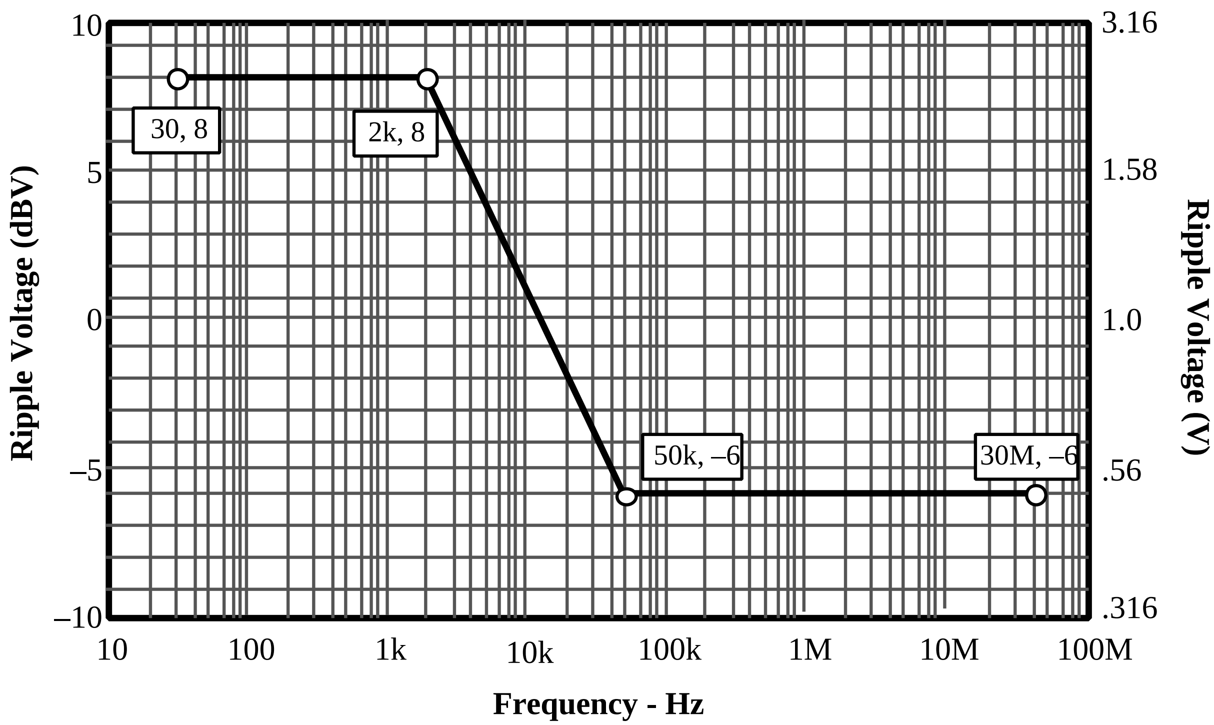
6.1.2.2.1 Ripple Voltage and Noise

The HRF rack shall operate and be compatible with the EPS time domain ripple voltage and noise level of 2.5 Vrms maximum within the frequency range of 30 Hz to 10k Hz. **[SSP 57000C, paragraph 3.2.1.2.1]**

6.1.2.2.2 Ripple Voltage Spectrum

The HRF rack shall operate and be compatible with the EPS ripple voltage spectrum as shown in Figure 6.1.2.2–1. **[SSP 57000C, paragraph 3.2.1.2.2]**

<u>Note</u>: This limit is 6 dB below the EMC CS-01, 02 requirement in SSP 30237 up to 30 MHz.



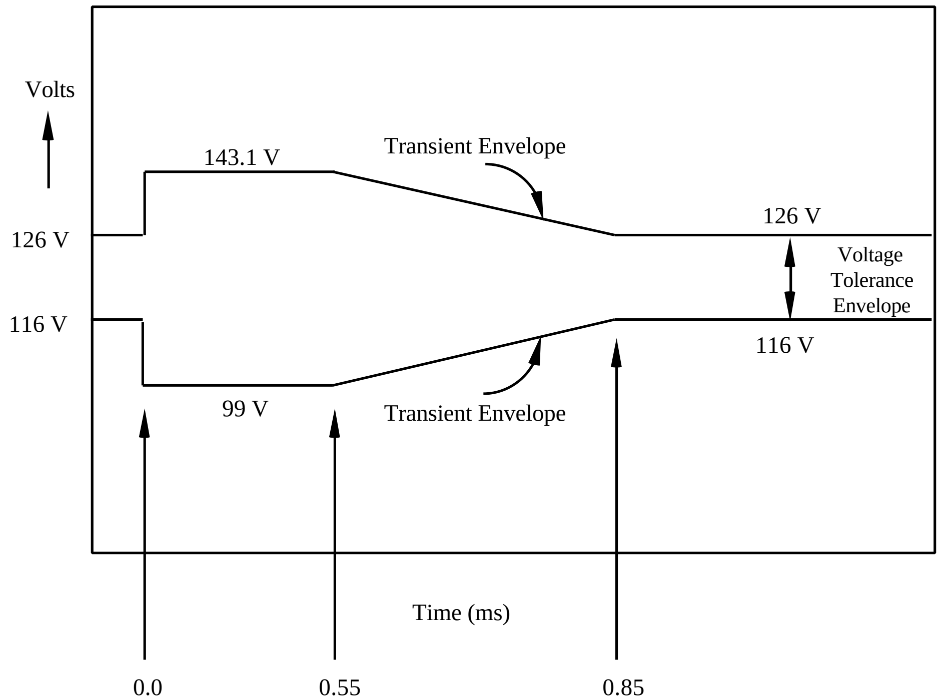
NOTE: 0.0 dBV = 1.0 Vrms

[SSP 57000C, FIGURE 3.2.1.2.2–1]

Figure 6.1.2.2–1. Maximum Ripple Voltage Spectrum

6.1.2.3 Transient Voltages

The HRF rack shall operate and be compatible with the limits of magnitude and duration for the voltage transients at Interface B as shown in Figure 6.1.2.3–1. The envelope shown in this figure applies to the transient responses exclusive of any periodic ripple and/or random noise components that may be present. **[SSP 57000C, paragraph 3.2.1.3.1]**



[SSP 57000C, FIGURE 3.2.1.3.1–1]

Figure 6.1.2.3–1. Interface B Voltage Transients

6.1.2.4 Fault Clearing and Protection

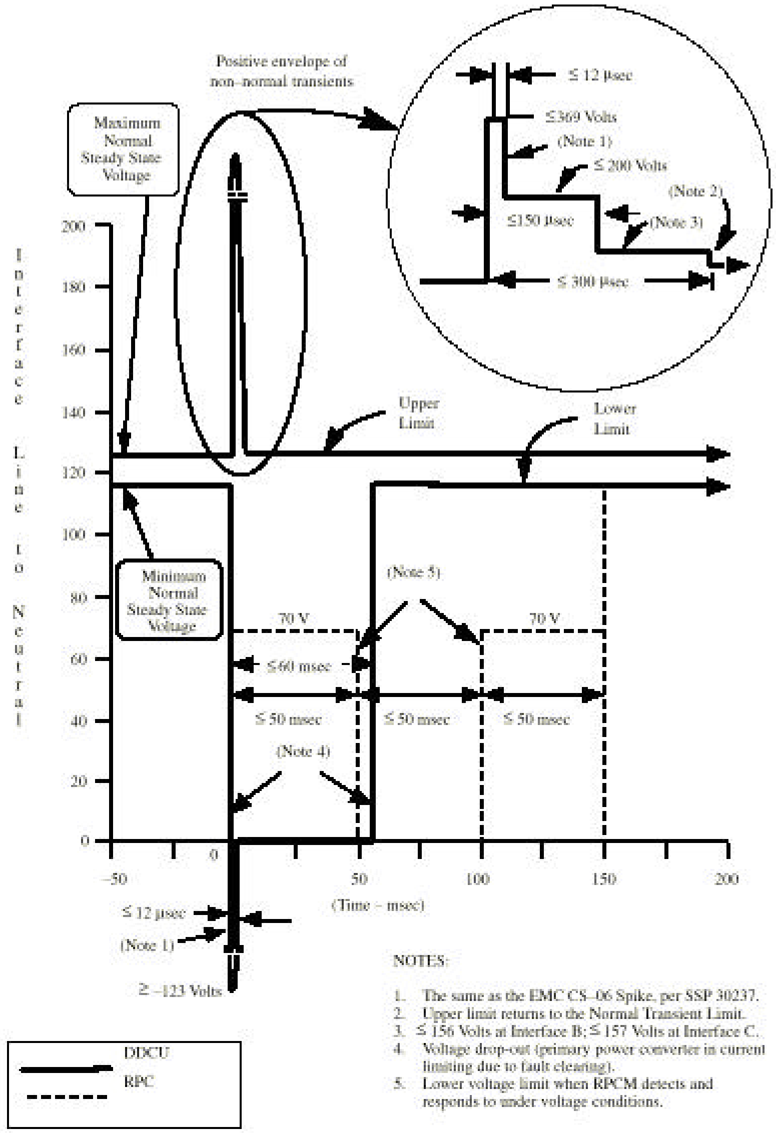
The HRF rack shall be safe and not suffer damage with the transient voltage conditions that are within the limits shown in Figure 6.1.2.4–1. Loads may be exposed to transient overvoltage conditions during operation of the power system's fault protection components. **[SSP 57000C, paragraph 3.2.1.3.3]**

6.1.2.5 Non-Normal Voltage Range

The HRF rack shall not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware with the following non-normal voltage characteristics**:**

A. Maximum overvoltage of + 165 Vdc for 10 sec. **[SSP 57000C, paragraph 3.2.1.3.4.A]**

B. Undervoltage conditions of +102 Vdc for an indefinite period of time. **[SSP 57000C, paragraph 3.2.1.3.4.B]**



[SSP 57000C, FIGURE 3.2.1.3.3–1]

Figure 6.1.2.4–1. Fault Clearing and Protection Transient Limits

6.1.2.6 Common Mode Noise

The HRF rack shall operate and be compatible with the power system maximum common mode noise present at Interface B defined as follows:

A. From 30 Hz to 50 kHz, Common Mode Voltage of 1.25 Vrms. **[SSP 57000C, paragraph 3.2.1.4.A]**

B. From 50 kHz to 30 MHz, Common Mode Current of 20 milliamperes (mA). **[SSP 57000C, paragraph 3.2.1.4.B]**

6.1.2.7 UIP Connectors and Pin Assignments

A. HRF rack power connectors P1 and P2 shall mate to the UIP connectors J1 and J2 specified in paragraph 6.1.1.6.1, A and B. **[SSP 57000C, paragraph 3.2.2.1.A] [note: see Table 6.1.1.6-1 rows A and B in this document]**

B. HRF rack connectors P1 and P2 shall meet the pin out interfaces of the UIP connectors J1 and J2 as specified in SSP 57001, paragraph 3.2.1.1. **[SSP 57000C, paragraph 3.2.2.1.B]**

C. HRF rack connectors P1 and P2 shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.2.2.1.C]**

6.1.2.8 Power Bus Isolation

A HRF rack locations requiring power from two independent ISS power buses shall provide a minimum of 1-megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance within internal and external rack Electrical Power Consuming Equipment (EPCE) at all times such that no single failure shall cause the independent power buses to be electrically tied. [Mutual capacitance is defined as line-to-line capacitance, exclusive of the Electromagnetic Interference (EMI) input filter.] **[SSP 57000C, paragraph 3.2.2.2.A]**

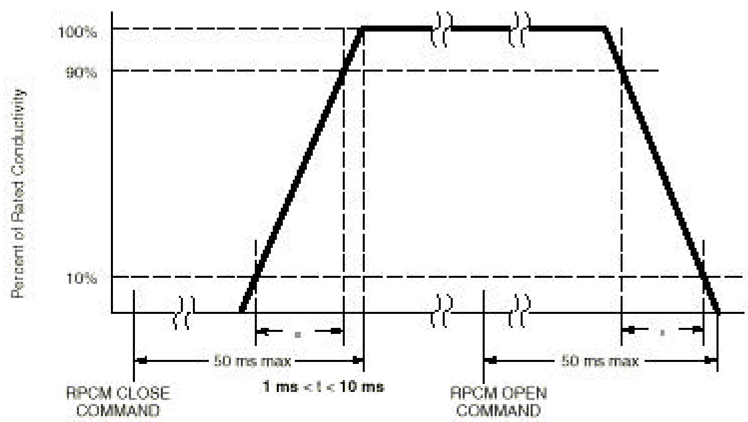
B. The HRF rack internal and external EPCE shall not use diodes to electrically tie together independent ISS power bus high side or return lines. These requirements apply to both supply and return lines. **[SSP 57000C, paragraph 3.2.2.2.B]**

ISS provides the capability to support simultaneous use of Main (J1) and Auxiliary (J2) power at each ISPR location (except MPLM). Constrained element level payload operations may occur from individual payload racks which automatically switch to or require simultaneous use of auxiliary power. ISS is required to reserve the maximum auxiliary power needed on that channelized Bus (even when not in use) to prevent Bus overload. For this reason, auxiliary power feeds will nominally be powered off by the module Remote Power Controller (RPC). Specific constraints on the use of auxiliary power will be defined in the payload unique ICD.

6.1.2.9 Compatibility With Soft Start/Stop RPC

The HRF rack shall initialize with the soft start/stop performance characteristics when power is applied, sustained, and removed by control of remote power control switches. The soft start/stop function, active only when the RPC is commanded on or off, is limited to 100 amps/ms, or less, by the RPC output. The response of the soft start/stop function is linear for resistive loads for 1 to 10 millisecond (ms) for U.S. LAB feeds, 1 to 2 ms for Japanese Experiment/Equipment Module (JEM) main and 0.2 ms for JEM 10 amp auxiliary feeds, and 1 to 5 ms for COF feeds between 0 amps and rated current level. **[SSP 57000C, paragraph 3.2.2.3]**

Note: Soft start/stop characteristics of U.S. standard RPCMs are shown in Figure 6.1.2.9–1.

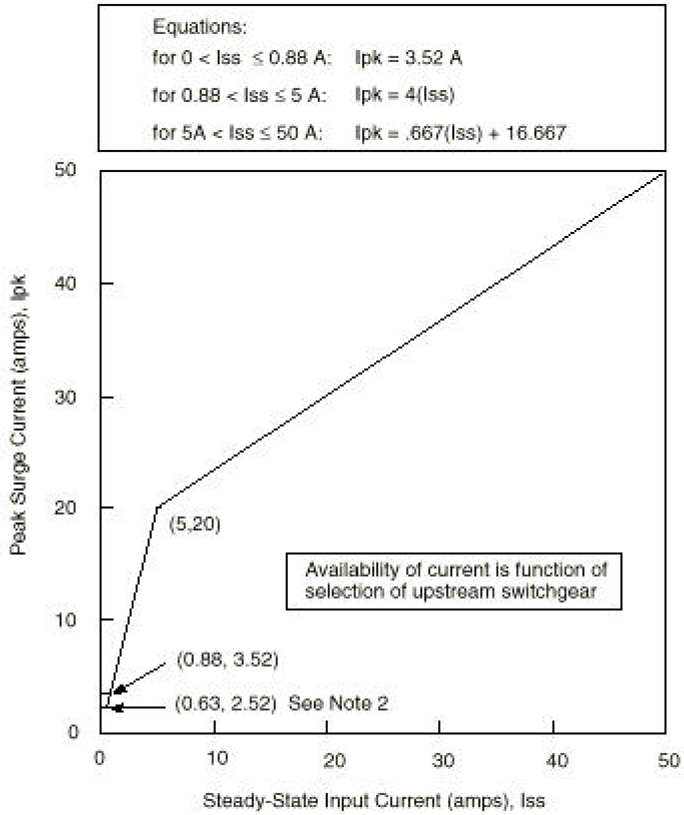


[SSP 57000C, FIGURE 3.2.2.3–1]

Figure 6.1.2.9–1. U.S. RPCM Soft Start/Stop Characteristics

6.1.2.10 Surge Current

The HRF rack surge current at the power inputs shall not exceed the surge current values defined in Figures 6.1.2.10–1 and 6.1.2.10–2 when powered from a voltage source with characteristics specified in paragraphs 6.1.2 and 6.1.2.9, with the exception that the source impedance is considered to be 0.1 ohm. The duration of the surge current shall not exceed 10 ms. These requirements apply to all operating modes and changes including power-up and power-down. **[SSP 57000C, paragraph 3.2.2.4]**

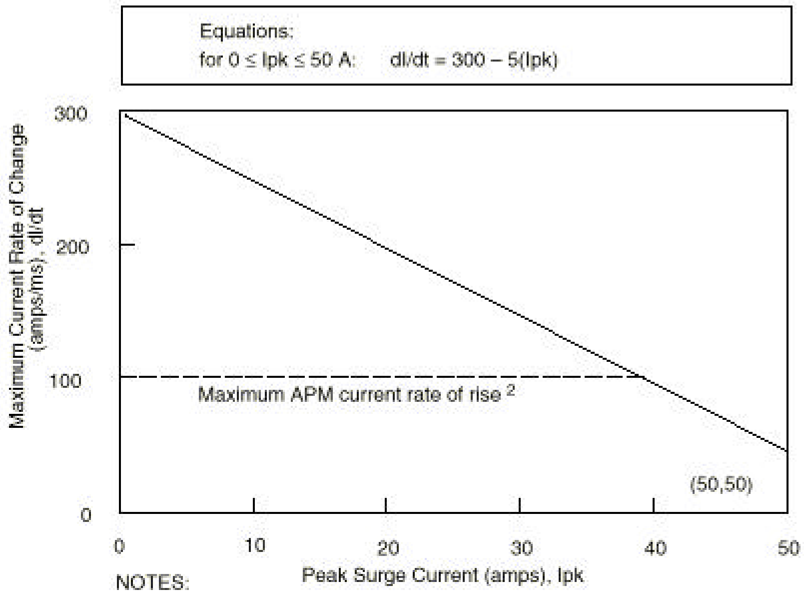


NOTES:

1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station equipment accommodated in JEM will have a maximum allowable peak surge current of 2.52 amps for equipment having a steady-state input no greater than 0.63 amps.

[SSP 57000C, FIGURE 3.2.2.4–1]

Figure 6.1.2.10–1. Peak Surge Current Amplitude Versus Steady-State Input Current



NOTES:

1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station and ISPR payload equipment accommodated in APM shall function correctly with a maximum current rate of rise of 100 amps/ms up to 40-amps peak surge current.

[SSP 57000B FIGURE 3.2.2.4–2]

Figure 6.1.2.10–2. Maximum Current Rate of Change Versus Peak Surge Current Amplitude

6.1.2.11 Reverse Energy/Current

The HRF rack electrical interface main input power and Auxiliary input power shall comply with the requirements defined in Table 6.1.2.11–1 for the reverse energy/current into the upstream power source. The HRF rack interface shall meet either the reverse energy or the reverse current requirement defined in Table 6.1.2.11-1 for all environmental conditions specified in this document when powered from a voltage source with characteristics specified in paragraphs 6.1.2 and 6.1.2.9 with a source impedance of 0.1 ohm. **[SSP 57000C, paragraph 3.2.2.5]**

TABLE 6.1.2.11–1. MAXIMUM REVERSE ENERGY/CURRENT FROM DOWNSTREAM LOADS

ISPR INTERFACE Power/RPCM Type	MAXIMUM REVERSE ENERGY (Joules)	MAXIMUM REVERSE CURRENT (amps)		
		Pulse t<10 ms	Pulse t<1 ms	Pulse t>1 s
3 kW/ type VI	3.0	400	250	3
6 kW/ type III	6.0	800	500	6
JEM	TBD	TBD	TBD	TBD
ESA	TBD	TBD	TBD	TBD
UOP Type I	1.5	400	250	2
UOP Type V	1.5	400	250	2
μs = microseconds ms = milliseconds s = second				

[SSP 57000C, TABLE 3.2.2.5–1]

6.1.2.12 Remote Power Controllers (RPCS)

A. The HRF rack shall operate and be compatible with characteristics in Figures 3.2.6–1, 3.2.6–2, and 3.2.6–3 as described in paragraph 3.2.6 located in SSP 57001. **[SSP 57000C, paragraph 3.2.2.6.1.1.A]**

B. Overcurrent protection shall be provided at all points in the system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines. **[SSP 57000C, paragraph 3.2.2.6.1.1.D]**

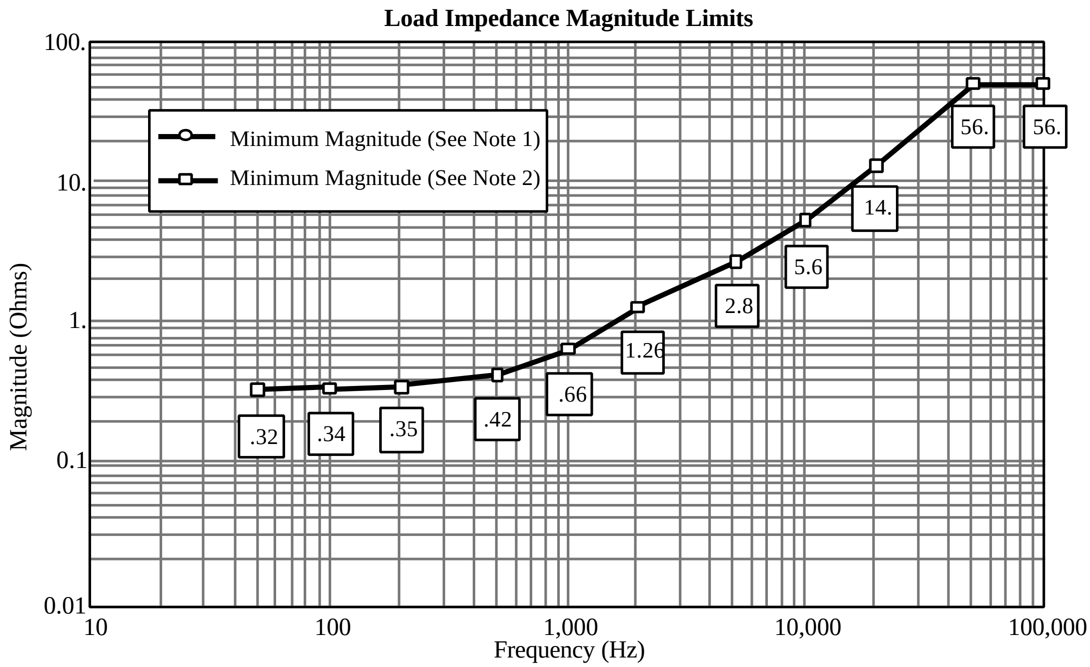
C. HRF racks shall provide current limiting overcurrent protection for all internal loads (exclusive of overcurrent protection circuits and devices) drawing power from an interface B power feed. For the purpose of this requirement, internal overcurrent protection circuits and devices are not considered to be loads. **[SSP 57000C, paragraph 3.2.2.6.1.1.E]**

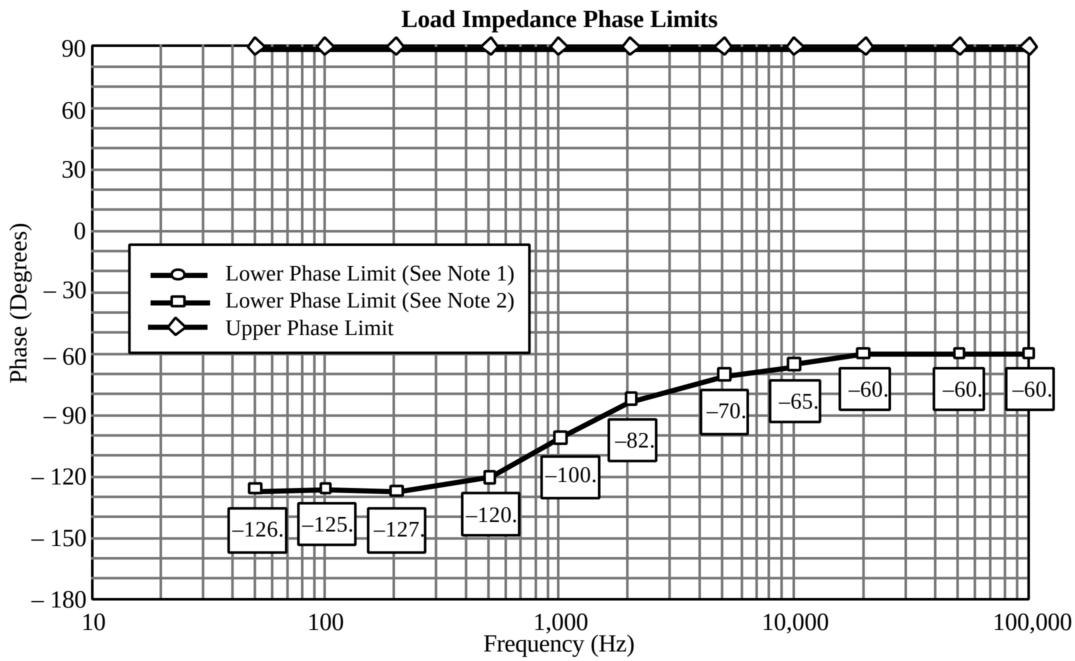
D. HRF rack-circuit protection device trip ratings shall be coordinated with the upstream RPC trip characteristics so that an event that activates protection in a downstream device will not also trip the one upstream. **[SSP 57000C, paragraph 3.2.2.6.2.1.1]**

6.1.2.13 Rack Complex Load Impedances

A. The load impedance presented by the HRF rack to the Main Interface B shall not exceed the bounds defined by Figures 6.1.2.13–1 and 6.1.2.13–2 for input over the frequency range of 50 Hz to 100 kHz. The magnitude component of the HRF rack input impedance should not be less than the minimum defined in Figures 6.1.2.13–1 and 6.1.2.13–2. At frequencies where the magnitude component of the HRF rack input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in these figures. **[SSP 57000C, paragraph 3.2.2.7.1.A]**

B. The load impedance presented by the HRF rack to the 1.2 to 1.44 kW interface B shall not exceed the bounds defined by Figure 6.1.2.13–3 for input over the frequency range of 50 Hz to 100 kHz. The magnitude component of the HRF rack input impedance should not be less than the minimum defined in Figure 6.1.2.13–3. At frequencies where the magnitude component of the HRF rack input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in this Figure. **[SSP 57000C, paragraph 3.2.2.7.1.B]**



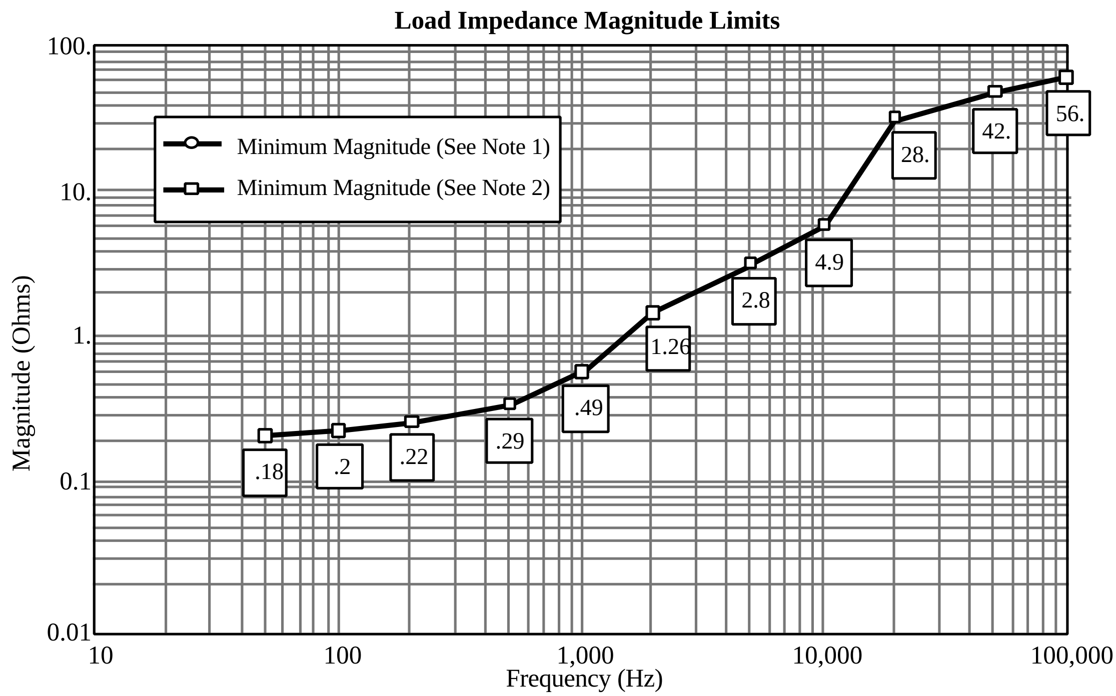


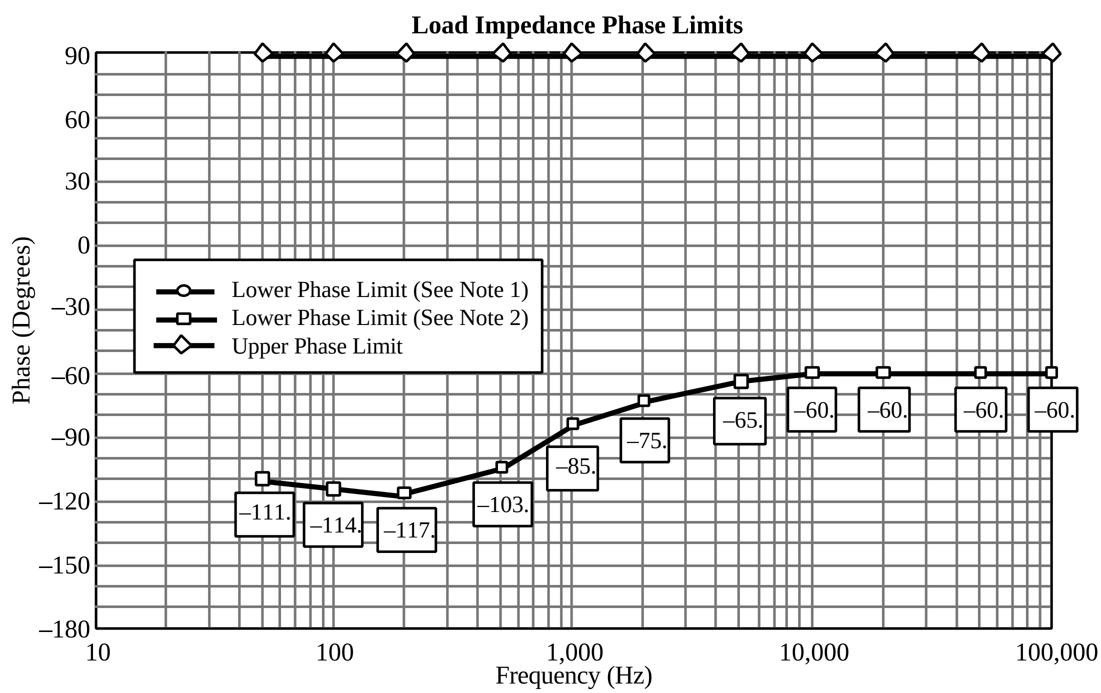
NOTES:

1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.

[SSP 57000C, FIGURE 3.2.2.7.1–1]

Figure 6.1.2.13–1. 3 Kw Interface B Load Impedance Limits



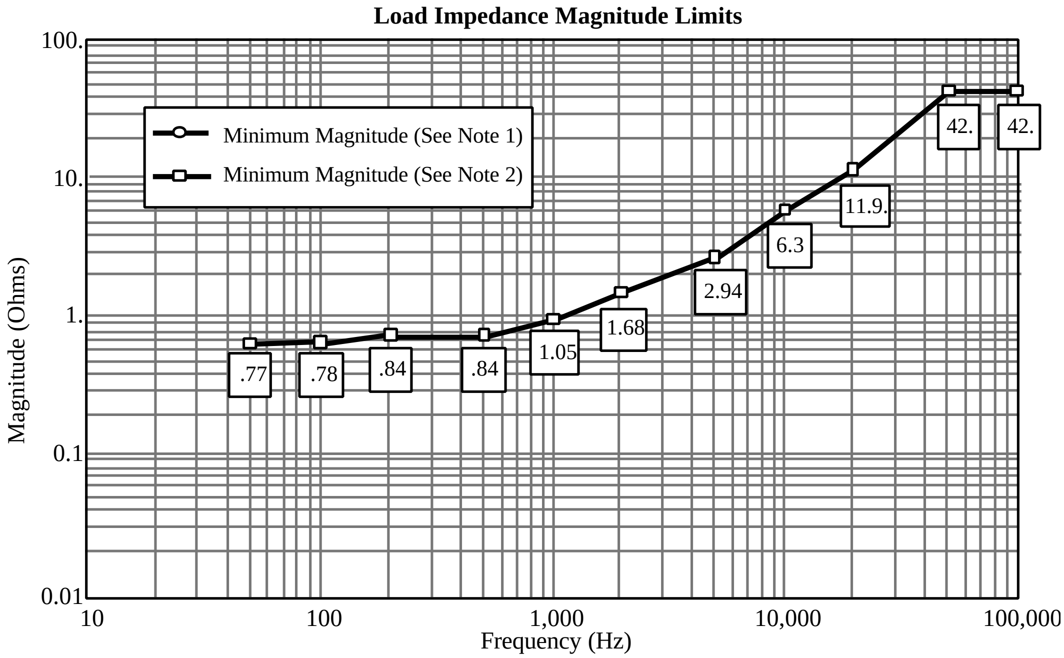


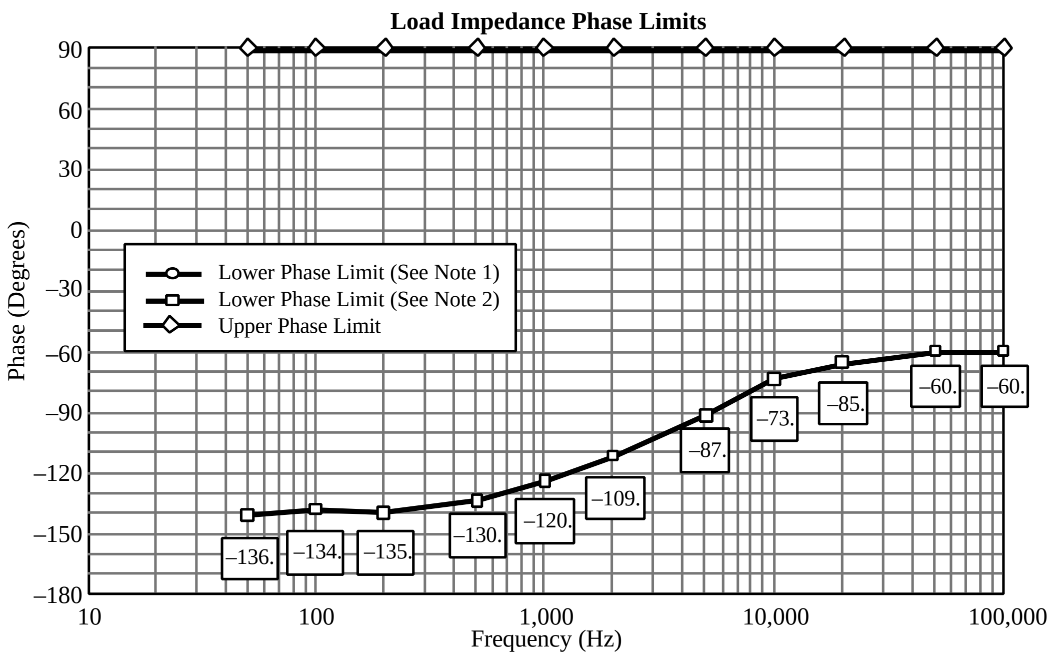
NOTES:

1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.

[SSP 57000C, FIGURE 3.2.2.7.1–2]

Figure 6.1.2.13-2. 6 Kw Interface B Load Impedance Limits





NOTES:

1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.

[SSP 57000C, FIGURE 3.2.2.7.1–3]

Figure 6.1.2.13–3. 1.2 To 1.44 Kw Auxiliary Interface B Load Impedance Limits

6.1.2.14 Large Signal Stability

The HRF rack shall maintain stability with the ISS EPS interface by damping a transient response to 10 percent of the maximum response amplitude within 1.0 ms, and remaining below 10 percent thereafter under the following conditions:

1. The rise time/fall time (between 10 and 90 percent of the amplitude) of the input voltage pulse is less than 10 microseconds (μs). **[SSP 57000C, paragraph 3.2.2.8.1]**

2. The voltage pulse is to be varied from 100 to 150 ms in duration. **[SSP 57000C, paragraph 3.2.2.8.2]**

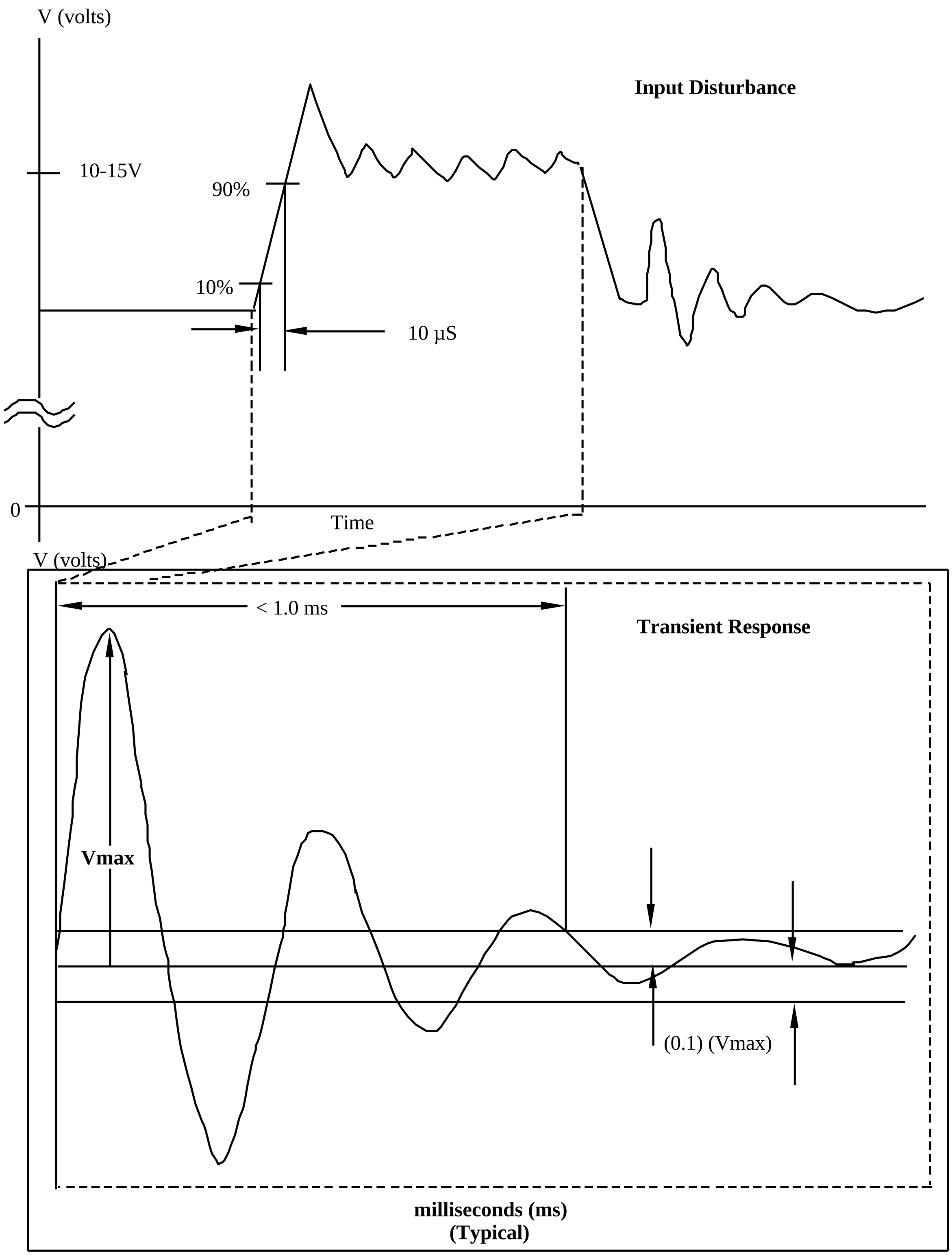
Note: Figure 6.1.2.14–1 is used to clarify the above requirement.

6.1.2.15 Maximum Ripple Voltage Emissions

The maximum ripple voltage induced on the power line by the HRF rack shall be no greater than 0.5 Volts (V) peak-to-peak. **[SSP 57000C, paragraph 3.2.2.9]**

6.1.2.16 Electrical Load-Stand Alone Stability

The HRF rack shall be locally stable. **[SSP 57000C, paragraph 3.2.2.10]**



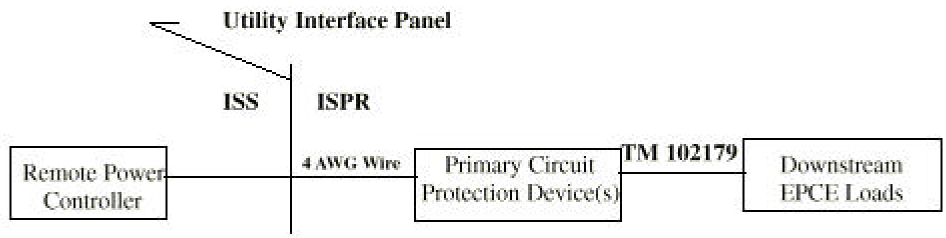
[SSP 57000C, FIGURE 3.2.2.8–1]

Figure 6.1.2.14–1. Pulse Applied to the Power Input of the HRF Rack

6.1.2.17 Wire Derating

A. Derating criteria for EPCE at and downstream of the primary circuit protection device(s) in the HRF rack, as shown in Figure 6.1.2.17–1, shall be per NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038. **[SSP 57000C, paragraph 3.2.3.1.B]**

B. HRF racks shall use 4 gauge wire for main and auxiliary connections at the UIP. **[SSP 57000C, paragraph 3.2.3.1.C]**



[SSP 57000C, FIGURE 3.2.3.1-1]

Figure 6.1.2.17-1. Wire Derating Requirements for ISPR and EPCE

6.1.2.18 Exclusive Power Feeds

A. The HRF rack shall receive power only from the UIP dedicated to its rack location. **[SSP 57000C, paragraph 3.2.3.2.A]**

B. Cabling shall not occur between Interface C connected EPCE with Interface B; and/or Interface B connected EPCE with Interface C. **[SSP 57000C, paragraph 3.2.3.2.B]**

6.1.2.19 Loss of Power

The HRF rack shall fail safe in the event of a total or partial loss of power regardless of the availability of Auxiliary power in accordance with NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.2.3.3]**

6.1.2.20 Electromagnetic Compatibility

The HRF rack shall meet the payload provider applicable requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. **[SSP 57000C, paragraph 3.2.4]**

6.1.2.20.1 Electrical Grounding

The HRF rack shall meet all requirements specified in section 3 of SSP 30240. **[SSP 57000C, paragraph 3.2.4.1]**

6.1.2.20.2 Electrical Bonding

HRF racks shall interface with the module bond strap per SSP 57001 Hardware ICD Template. Electrical bonding of HRF racks to Interface B shall be in accordance with SSP 30245 and NSTS 1700.7B, ISS Addendum sections 213 and 220. **[SSP 57000C, paragraph 3.2.4.2]**

6.1.2.20.3 Cable/Wire Design and Control Requirements

Cabling between HRF racks and Interface B shall meet all Cable and Wire Design requirements of SSP 30242. **[SSP 57000C, paragraph 3.2.4.3]**

6.1.2.20.4 Electromagnetic Interference

HRF racks shall meet all EMI requirements of SSP 30237. **[SSP 57000C, paragraph 3.2.4.4]**

Note: The alternative use of RS03 stated below applies to radiated susceptibility requirements only.

Alternately, HRF racks may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown below, will hereafter be denoted RS03PL.

FREQUENCY	RS03PL LIMIT (V/m)
14 kHz – 400 MHz	5
400 MHz – 450 MHz	30
450 MHz – 1 GHz	5
1 GHz – 5 GHz	25
5 GHz – 6 GHz	60
6 GHz – 10 GHz	20
13.7 GHz – 15.2 GHz	25

COMMENTS: The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable. The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

6.1.2.20.5 Alternating Current (AC) Magnetic Fields

The generated ac magnetic fields, measured at a distance of 7 centimeters (cm) from the generating equipment, shall not exceed 140 dB above 1 picotesla for frequencies ranging from 30 Hz to 2 kHz, then falling 40 dB per decade to 50 kHz. **[SSP 57000C, paragraph 3.2.4.6]**

6.1.2.20.6 Direct Current (DC) Magnetic Fields

The generated DC magnetic fields shall not exceed 170 dB picotesla at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices. **[SSP 57000C, paragraph 3.2.4.7]**

6.1.2.21 Electrostatic Discharge

Unpowered EPCE and components shall not be damaged by Electrostatic Discharge (ESD) equal to or less than 4,000 V to the case or any pin on external connectors. EPCE that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. Labeling of EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL–STD–1686. These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal. **[SSP 57000C, paragraph 3.2.4.5]**

6.1.2.22 Corona

HRF rack electrical and electronic subsystems, equipment, and systems shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC–STD–531, High Voltage Design Criteria. **[SSP 57000C, paragraph 3.2.4.8]**

6.1.2.23 Lightning

The HRF rack shall meet the lightning induced environment requirement in paragraph 3.2.8.1 of SSP 30243. **[SSP 57000C, paragraph 3.2.4.9]**

6.1.2.24 EMI Susceptibility for Safety-Critical Circuits

Payload safety-critical circuits, as defined in SSP 30243, shall meet the margins defined in SSP 30243, paragraph 3.2.3. **[SSP 57000C, paragraph 3.2.4.10]**

6.1.2.25 Payload Electrical Safety

6.1.2.25.1 Mating/Demating of Powered Connectors

EPCE shall meet the electrical safety requirements as defined in NSTS 1700.7B, ISS Addendum. Payloads shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-97-093. **[SSP 57000C, paragraph 3.2.5.1.1]**

Note: The module can provide one verifiable upstream inhibit which removes voltage from the UIP connectors. The module design will provide the verification of the inhibit status at the time the inhibit is inserted. The use of the integrated rack power removal switch through J43 does not provide an additional inhibit.

6.1.2.25.2 Safety-Critical Circuits Redundancy

HRF racks shall meet the electrical safety requirements as defined in NSTS 1700.7B, ISS Addendum. HRF racks connected to Interface B shall meet the safety-critical circuits redundancy requirements defined in NSTS 18798. **[SSP 57000C, paragraph 3.2.5.1.2]**

6.1.2.25.3 HRF Rack Power Removal Switch

The HRF rack shall provide a guarded, two-position, manual switch installed in a visible and accessible location on the front of the rack that removes all power to the rack. **[SSP 57000C, paragraph 3.2.5.2]**

Note: Implementation of the integrated rack power removal switch through the J43 connector as specified in paragraph 3.3.9 meets the intent of this requirement. **[SSP 57000C, paragraph]**

6.1.2.25.4 Power Switches/Controls

A. Switches/controls performing on/off power functions for the HRF rack on/off power functions shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position. **[SSP 57000C, paragraph 3.2.5.3.A]**

B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. **[SSP 57000C, paragraph 3.2.5.3.B]**

C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition. **[SSP 57000C, paragraph 3.2.5.3.C]**

6.1.2.25.5 Ground Fault Circuit Interrupters (GFCI)/Portable Equipment Dc Sourcing Voltage

A. A non-portable utility outlet with output voltages exceeding 30 volts rms or DC nominal (32 volts rms or DC maximum) intended to supply power to portable equipment shall include a Ground Fault Circuit Interrupters (GFCI), as an electrical hazard control, in the power path to the portable equipment. **[SSP 57000C, paragraph 3.2.5.4.A]**

B. GFCI trip current DC detection shall be independent of the portable equipment's safety (green) wire. **[SSP 57000C, paragraph 3.2.5.4.B]**

C. GFCI trip current AC detection shall be dependent on the portable equipment's safety (green) wire when the safety (green) wire is present. **[SSP 57000C, paragraph 3.2.5.4.C]**

D. Portable equipment that generates internal voltages greater than 30 volts rms or DC nominal (32 volts rms or DC maximum) and has a credible fault path or return path to a crewmember shall include GFCI protection for that credible path with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table 6.1.2.25.5–1. **[SSP 57000C, paragraph 3.2.5.4.D]**

E. GFCI will be designed to trip below the threshold of let-go based upon the 99.5 percentile rank of adults. Non-portable utility outlets supplying power to portable equipment shall include a GFCI with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table 6.1.2.25.5–1. **[SSP 57000C, paragraph 3.2.5.4.E]**

F. GFCIs shall remove power within 25 milliseconds upon encountering the fault current. **[SSP 57000C, paragraph 3.2.5.4.F]**

G. GFCI shall provide an on-orbit method for testing trip current detection threshold at DC and at a frequency within the maximum human sensitivity range of 15 to 70 Hertz. **[SSP 57000C, paragraph 3.2.5.4.G]**

Note: The definitions of hazard requirements are specified in NSTS 1700.7B, ISS Addendum, paragraph 200.

TABLE 6.1.2.25.5–1. LET-GO CURRENT PROFILE THRESHOLD VERSUS FREQUENCY

Frequency	**Maximum Total Peak Current (AC + DC components combined) milliamperes**
DC	40.0
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
10000	24.3
50000	24.3
(Based on 99.5 Percentile Rank of Adults)	

[SSP 57000B TABLE 3.2.5.4–1]

6.1.3 Command and Data Handling Interface Requirements

6.1.3.1 Word/Byte Notations, Types and Data Transmissions

This section applies to all payload commands and data on the Low Rate Data Link (LRDL), all header/trailer data on the Medium Rate Data Link (MRDL) and High Rate Data Link (HRDL).

6.1.3.1.1 Word/Byte Notations

HRF racks shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. **[SSP 57000C, paragraph 3.3.2.1]**

6.1.3.1.2 Data Types

HRF racks shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. **[SSP 57000C, paragraph 3.3.2.2]**

6.1.3.1.3 Data Transmissions

A. HRF rack data transmission on LRDL, MIL–STD–1553B shall use the data transmission order in accordance with paragraph 3.4, Non-Signal Data Coding Standards in D684–10056–01, Prime Contractor Software Standards and Procedures Specification. **[SSP 57000C, paragraph 3.3.2.3.A]**

B. HRF rack data transmission on MRDL shall use the data transmission order in accordance with paragraph 3.3.3.1, Transmission Order in SSP 52050. **[SSP 57000C, paragraph 3.3.2.3.B]**

C. The HRF rack data transmission on HRDL shall use the data transmission order in accordance with paragraph 1.6, Bit Numbering Convention and Nomenclature in CCSDS 701.0–B–2. **[SSP 57000C, paragraph 3.3.2.3.C]**

6.1.3.2 Consultative Committee for Space Data Systems

HRF racks will use the Consultative Committee for Space Data Systems (CCSDS) standards for Space to Ground and Ground to Space data and time requirements as specified in this section. **[SSP 57000C, paragraph 3.3.4]**

6.1.3.2.1 CCSDS Data

HRF rack data that is space to ground shall be either CCSDS Data Packets or CCSDS Bitstream. HRF rack data that is ground to space or HRF rack to Payload Multiplexer/Demultiplexer Module (MDM) shall be CCSDS Data Packets. **[SSP 57000C, paragraph 3.3.4.1]**

6.1.3.2.1.1 CCSDS Data Packets

HRF rack data packets shall be developed in accordance with paragraph 3.1.3 of SSP 52050. HRF rack CCSDS data packets consist of a primary header and a secondary header followed by the data field. **[SSP 57000C, paragraph 3.3.4.1.1]**

6.1.3.2.1.1.1 CCSDS Primary Header

HRF racks shall develop a CCSDS primary header in accordance with paragraph 3.1.3.1 CCSDS Primary Header Format of SSP 52050. **[SSP 57000C, paragraph 3.3.4.1.1.1]**

6.1.3.2.1.1.2 CCSDS Secondary Header

HRF racks shall develop a CCSDS secondary header immediately following the CCSDS primary header. The CCSDS secondary header shall be developed in accordance with paragraph 3.1.3.2, CCSDS Secondary Header Format of SSP 52050. **[SSP 57000C, paragraph 3.3.4.1.1.2]**

6.1.3.2.1.2 CCSDS Data Field

HRF rack CCSDS data field shall contain the integrated rack data from the transmitting application to the receiving application, and the CCSDS checksum in accordance with SSP 57002. **[SSP 57000C, paragraph 3.3.4.1.2]**

6.1.3.2.1.3 CCSDS Data Bitstream

HRF rack bitstream data shall be developed in accordance with paragraph 2.3.2.3, Bitstream Service of CCSDS 701.0–B–2. **[SSP 57000C, paragraph 3.3.4.1.3]**

6.1.3.2.1.4 CCSDS Application Process Identification Field

The CCSDS Application Process Identification (APID) field format shall be in accordance with paragraph 3.3.2.1.3.4 CP–PDU Application Process Identification of SSP 41175–2. The APID will be in accordance with paragraph TBD, Integrated Rack Software ICD SSP 57002, then recorded in the unique Integrated Rack Software ICD. **[SSP 57000C, paragraph 3.3.4.1.4]**

6.1.3.2.2 CCSDS Time Codes

6.1.3.2.2.1 CCSDS Unsegmented Time

HRF racks shall use CCSDS unsegmented time code Computer Usage Control (CUC) in the secondary header as specified in paragraph 2.2, Unsegmented Time, of CCSDS 301.0–B–2. **[SSP 57000C, paragraph 3.3.4.2.1]**

6.1.3.2.2.2 CCSDS Segmented Time

Segmented time code will be sent to the HRF rack by a broadcast message on the Payload MIL–STD–1553B. Segmented time code formats are specified in paragraph 2.4, Calendar Segmented Time of CCSDS 301.0–B–2. **[SSP 57000C, paragraph 3.3.4.2.2]**

The broadcast time will be received at subaddress #29 on each Payload MIL–STD–1553B bus. The broadcast time signal will be updated once a second and is accurate to ±2.5 ms.

6.1.3.3 MIL-STD-1553B Low Rate Data Link (LRDL)

HRF racks shall implement a single MIL–STD–1553B Remote Terminal (RT) to the payload unique MIL–STD–1553B bus A and implement a single MIL–STD–1553B Remote Terminal (RT) to the payload unique MIL–STD–1553B bus B. **[SSP 57000C, paragraph 3.3.5]**

6.1.3.3.1 MIL-STD-1553B Protocol

6.1.3.3.1.1 Standard Messages

HRF racks shall develop standard message for the Payload MIL–STD–1553B in accordance with paragraph 3.2.3.3, Standard Messages of SSP 52050. **[SSP 57000C, paragraph 3.3.5.1.1]**

6.1.3.3.1.2 Commanding

HRF racks shall receive and process commands from the Payload MDM that originate from the Ground, Timeliner, Payload MDM and Portable Computer System (PCS) in accordance with paragraph 3.2.3.4, Commanding of SSP 52050 and SSP 41175–2. **[SSP 57000C, paragraph 3.3.5.1.2]**

6.1.3.3.1.3 Health and Status Data

HRF racks shall develop health and status data in accordance with paragraph 3.2.3.5 Health and Status of SSP 52050. The health and status data shall be documented in accordance with the data field format defined in Table A–5 of SSP 57002. The definition of health and status data is provided in the Glossary of Terms of SSP 57002, Appendix B. **[SSP 57000C, paragraph 3.3.5.1.3]**

HRF racks shall respond to their respective payload MDM polls for health and status data with updated data at a 1 Hz or 0.1 Hz rate.

6.1.3.3.1.4 Safety Data

A. HRF racks shall develop safety data in accordance with paragraph 3.2.3.6, Safety Data of SSP 52050. The safety data format, and module unique requirements, shall be developed in accordance with paragraph TBD, in SSP 57002. **[SSP 57000C, paragraph 3.3.5.1.4]**

B. HRF racks shall provide as safety data the standard rack Caution and Warning (C&W) status words in accordance with paragraph TBD, SSP 57002. **[SSP 57000C, paragraph 3.3.5.1.4]**

6.1.3.3.1.4.1 Caution and Warning

For the purpose of C&W classifications, the sensors are the integrated racks means of detecting events that were deemed necessary by the Phased Safety Review Panel (PSRP) during the Phased Safety Reviews. The sensors used to produce C&W Events are determined by the payload developer, advisories may be set if the payload developer identifies a situation that meets the classification of an advisory.

6.1.3.3.1.4.1.1 Class 1 – Emergency

All of the defined ISS Emergency conditions are reported by the ISS systems or the rack smoke detector, HRF racks and equipment will not report an Emergency condition.

(1) The emergency condition rapid cabin depressurization will be detected by the ISS module sensors.
(2) The emergency condition of toxic atmosphere is set as a scar.
(3) Payload Fire emergency's can only be declared as a confirmed fire event by the ISS rack smoke detector or equivalent, which can detect 96% of the smoke detector failures.

When an emergency event is detected, the format of the data will identify the event type (fire, toxic atmosphere, depressurization)

Emergency conditions require all onboard crew to respond immediately.

6.1.3.3.1.4.1.2 Class 2 – Warning

HRF racks shall format the C&W word as specified in SSP 52050 paragraph 3.2.3.5 as a warning when the HRF rack sensors detect the following conditions: **[SSP 57000C, paragraph 3.3.5.1.4.1.2]**

(1) A potential fire event, (detected by a sensor other than an ISS rack smoke detector or equivalent)

(2) A precursor event that could manifest to an emergency condition (toxic atmosphere, rapid cabin depressurization or fire) and
    (a) automatic safing has failed to safe the event or
    (b) the system is not automatically safed (i.e. requires manual intervention)

(3) An event that results in the loss of a hazard control and
    (a) automatic safing has failed to safe the event or
    (b) the system is not automatically safed (i.e. requires manual intervention)

Note: Warning requires someone to take action immediately. Warnings are used for events that require manual intervention and for notification when automatic safing fails.

6.1.3.3.1.4.1.3 Class 3 – Caution

HRF racks shall format the C&W word as specified in SSP 52050 paragraph 3.2.3.5 as a caution when the HRF rack sensors detect the following conditions: **[SSP 57000C, paragraph 3.3.5.1.4.1.3]**

(1) A precursor event that could manifest to an emergency condition (toxic atmosphere, rapid cabin depressurization or fire) and automatic safing has safed the event (i.e. the system does not require manual intervention)

(2) An event that results in the loss of a hazard control and automatic safing has safed the event (i.e., the system does not require manual intervention)

Note: A Caution requires no immediate action by the crew. Automatic safing has controlled the event.

6.1.3.3.1.4.1.4 Class 4 – Advisory

HRF racks that require an advisory shall format the C&W word as specified in SSP 52050 paragraph 3.2.3.5 as an advisory. Advisories are set for the following conditions: **[SSP 57000C, paragraph 3.3.5.1.4.1.4]**

(1) Advisories are set primarily for ground monitoring purposes (advantageous due to limited comm. coverage and data recording).

(2) Data item that most likely will not exist permanently in Telemetry List but should be time tagged and logged for failure isolation, trending, sustaining engineering, etc.

6.1.3.3.1.5 Service Requests

HRF racks shall develop service requests shall be in accordance with paragraph 3.2.3.7, Service Requests of SSP 52050. The service requests data format, shall be developed in accordance with paragraph TBD, of SSP 57002. **[SSP 57000C, paragraph 3.3.5.1.5]**

6.1.3.3.1.6 Ancillary Data

HRF racks shall develop data for use as ancillary data in accordance with paragraph 3.2.3.8, Ancillary Data of SSP 52050. The ancillary data format, shall be developed in accordance with paragraph TBD, in SSP 57002. **[SSP 57000C, paragraph 3.3.5.1.6]**

6.1.3.3.1.7 File Transfer

HRF racks shall develop file transfer in accordance with paragraph 3.2.3.9, File Transfer of SSP 52050. The file transfer data format, shall be developed in accordance with paragraph TBD, in SSP 57002. **[SSP 57000C, paragraph 3.3.5.1.7]**

6.1.3.3.1.8 Low Rate Telemetry

HRF racks shall develop low rate telemetry in accordance with paragraph 3.2.3.10, Low Rate Telemetry of SSP 52050. The low rate data format, shall be developed in accordance with paragraph TBD, in SSP 57002. **[SSP 57000C, paragraph 3.3.5.1.8]**

6.1.3.3.1.9 Defined Mode Codes

HRF racks MIL–STD–1553B mode codes are defined in paragraph 3.2.3.2.1.5, Data Word Count/Mode Code in SSP 52050.

6.1.3.3.1.10 Implemented Mode Codes

HRF racks shall implement MIL–STD–1553B mode codes in accordance with paragraph 3.2.3.2.1.5, Data Word Count/Mode Code in SSP 52050. **[SSP 57000C, paragraph 3.3.5.1.10]**

6.1.3.3.1.11 Unimplemented/Undefined Mode Codes

The HRF rack MIL–STD–1553B Remote Terminal (RT) shall be designed to recognize both unimplemented and undefined mode codes as illegal commands. **[SSP 57000C, paragraph 3.3.5.1.11]**

6.1.3.3.1.12 Illegal Commands

The HRF rack MIL–STD–1553B RT shall respond to illegal commands by setting the message error bit in the status word. **[SSP 57000C, paragraph 3.3.5.1.12]**

6.1.3.3.2 MIL-STD-1553B Low Rate Data Link (LRDL) Interface Characteristics

6.1.3.3.2.1 LRDL Remote Terminal Assignment

6.1.3.3.2.1.1 LRDL Connector/Pin Assignments

6.1.3.3.2.1.2 MIL–STD–1553B Bus A Connector/Pin Assignment

A. HRF rack connector P3 mating requirements to the Utility Interface Panel (UIP) connector J3 are specified in paragraph 6.1.1.6, C. **[SSP 57000C, paragraph 3.3.5.2.1.2.A] [note: see Table 6.1.1.6-1 row C in this document]**

B. HRF rack connector P3 shall meet the pin out interfaces of the UIP J3 connector as specified in SSP 57001, paragraph 3.3.2.2. **[SSP 57000C, paragraph 3.3.5.2.1.2.B]**

C. HRF rack connector P3 shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.3.5.2.1.2.C]**

D. HRF rack MIL–STD–1553B Bus A connector, P3, shall be SSQ 21635, NATC06G15N35PN or equivalent, provided it mates with ISPR Utility Interface Panel connector, J3, SSQ 21635, NATC07T15N35SN. **[SSP 57000C, paragraph 3.3.5.2.1.2.D]**

6.1.3.3.2.1.3 MIL–STD–1553B Bus B Connector/Pin Assignment

A. HRF rack connector P4 mating requirements to the UIP connector J4 are specified in paragraph 6.1.1.6, D. **[SSP 57000C, paragraph 3.3.5.2.1.3.A] [note: see Table 6.1.1.6-1 row D in this document]**

B. HRF rack connector P4 shall meet the pin out interfaces of the UIP J4 connector as specified in SSP 57001, paragraph 3.3.2.2. **[SSP 57000C, paragraph 3.3.5.2.1.3.B]**

C. HRF rack connector P4 shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.3.5.2.1.3.C]**

D. HRF rack MIL–STD–1553B Bus B connector, P4, shall be SSQ 21635, NATC06G15N35PA or equivalent, provided it mates with ISPR Utility Interface Panel connector, J4, SSQ 21635, NATC07T15N35SA. **[SSP 57000C, paragraph 3.3.5.2.1.3.D]**

6.1.3.3.2.2 LRDL Signal Characteristics

A. HRF racks which require connectivity to the payload local MIL-STD-1553B bus shall meet the electrical characteristics in accordance with MIL-STD-1553B. **[SSP 57000C, paragraph 3.3.5.2.2]**

B. The HRF rack MIL–STD–1553B terminal characteristics shall be in accordance with paragraph 4.5.2, Terminal Characteristics of MIL–STD–1553B. **[SSP 57000C, paragraph 3.3.5.2.2]**

6.1.3.3.2.3 LRDL Cabling

The HRF rack MIL–STD–1553B internal wiring characteristics shall be according to SSQ 21655, Cable, Electrical, MIL–STD–1553B Data Bus, Space Quality, General Specification for 75 Ohm or equivalent. **[SSP 57000C, paragraph 3.3.5.2.3]**

The HRF rack MIL–STD–1553B internal wiring characteristics are summarized in Table 6.1.3.3–1, MIL–STD–1553B Cable Characteristic.

TABLE 6.1.3.3–1. MIL–STD–1553B NETWORK CHARACTERISTICS

Type	**Twisted Shielded Pair**
Characteristic Impedance	75 ± 5 Ohm
Cable Size	22 AWG or 24 AWG
Nominal wire-to-wire Capacitance	66 pf/m

[SSP 57000C, TABLE 3.3.5.2.3-1]

The HRF rack MIL–STD–1553B internal wiring stub length shall not exceed 12 feet, 3.65 meters, when measured from the internal MIL–STD–1553B Remote Terminal to the ISPR Utility Interface Panel. **[SSP 57000C, paragraph 3.3.5.2.3]**

6.1.3.4 Medium Rate Data Link (MRDL)

6.1.3.4.1 MRDL Protocol

HRF racks that communicate via the MRDL shall conform with ISO/IEC 8802–3 10–Base-T protocol in accordance with paragraph 3.3, Medium Rate Data Link of SSP 52050. **[SSP 57000C, paragraph 3.3.6.1]**

6.1.3.4.1.1 HRF Rack Protocols on the MRDL

HRF racks that communicate via the MRDL shall conform with ISO/IEC 8802–3 10–Base-T protocol in accordance with paragraph 3.3, MRDL of SSP 52050. **[SSP 57000C, paragraph 3.3.6.1.1]**

Payloads sending data to the ground through the USOS Space to Ground Link shall use the CCSDS protocol and gateway protocol in paragraph 3.3.4, Gateway Protocol and 3.3.7 Packet Length in SSP 52050. **[SSP 57000C, paragraph 3.3.6.1.1]**

6.1.3.4.1.2 MRDL Address

A. HRF racks implementing MRDL shall have a unique Institute of Electrical and Electronic Engineers (IEEE) issued physical address. Payloads that are internal to the HRF rack shall have a unique IEEE issued physical address. **[SSP 57000C, paragraph 3.3.6.1.2]**

B. The unique address shall be set prior to the Ethernet terminal going active. The HRF rack will indicate the unique physical address in the payload unique ICD. Recommendation to the HRF rack developer is to hard code the unique address. **[SSP 57000C, paragraph 3.3.6.1.2]**

6.1.3.4.1.3 ISPR MRDL Connectivity

ISPR MRDL connectivity information may be found in section 3.3, Medium Rate Data Link, of SSP 52050.

A. The HRF rack with a MRDL connection shall have no more than one physical connection per LAN. The HRF rack with a MRDL connection may have one physical connection to LAN–1 and one physical connection to LAN–2. LAN–1 is located in J46 and LAN–2 is located in J47. **[SSP 57000C, paragraph 3.3.6.1.3.A]**

B. The HRF rack shall not route or transmit the same MRDL message to the ISS LANs simultaneously. **[SSP 57000C, paragraph 3.3.6.1.3.B]**

C. The HRF rack with internal MRDL(s) shall provide isolation between the ISS MRDL LANs and the internal LANs with either an Ethernet Bridge or an Internet Protocol router that connects the LAN–1 and LAN–2 to the internal rack LAN(s). **[SSP 57000C, paragraph 3.3.6.1.3.C]**

D. Ethernet device connected to the ISS LAN shall have a (unique) IEEE issued address. **[SSP 57000C, paragraph 3.3.6.1.3.D]**

6.1.3.4.1.4 MRDL Connector/Pin Assignments and Wire Requirements

A. HRF rack connectors P46 and P47 mating requirements to the UIP connectors J46 and J47 are specified in paragraph 6.1.1.6, I and J. **[SSP 57000C, paragraph 3.3.6.1.4.A] [note: see Table 6.1.1.6-1 rows I and J in this document]**

B. HRF rack connectors P46 and P47 shall meet the pin out interfaces of the UIP J46 and J47 connectors as specified in SSP 57001, paragraph 3.3.3.1. **[SSP 57000C, paragraph 3.3.6.1.4.B]**

C. HRF rack LAN–1 and LAN–2 connectors P46 and P47 shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.3.6.1.4.C]**

D. HRF rack LAN–1 and LAN–2 wire shall meet the requirements of 100 Ohm twisted-pair per SSQ 21655 or equivalent. The 100 Ohm twisted shielded pair cable defined in SSQ 21655 must be used due to its characteristics at MRDL data transmission frequencies. **[SSP 57000C, paragraph 3.3.6.1.4.D]**

6.1.3.4.1.5 MRDL Signal Characteristics

Payloads which require connectivity to the MRDL shall meet the electrical characteristics of MRDL in accordance with ISO/IEC 8802–3 with the following exceptions. **[SSP 57000C, paragraph 3.3.6.1.5]**

IEC Publication	60	High-Voltage Test Techniques
IEC Publication	380	Safety of Electrically Energized Office Machines
IEC Publication	435	Safety of Data Processing Equipment
IEC Publication	950	Safety of Information Technology Equipment, Including Electrical Business Equipment

6.1.3.4.1.6 MRDL Cable Characteristics

The cable characteristics are given in Table 6.1.3.4–1. **[SSP 57000C, paragraph 3.3.6.1.6]**

TABLE 6.1.3.4–1. LINK SEGMENT CABLE CHARACTERISTICS

Characteristic	**Parameter**
Characteristic Impedance	100 ± 7 Ohm
Cable Size	22 AWG
Type of Cable	Twisted Shielded Pair SSQ 21655 or Equivalent
Nominal wire-to-wire Capacitance	45 pF/m
Max Cable Length in ISPR	5 m

[SSP 57000C, TABLE 3.3.6.1.6–1]

6.1.3.4.1.6.1 Insertion Loss

The ISPR insertion losses will meet the requirements specified in paragraph 14.4.2.1 of ISO/IEC 8802–3 with the exception that the wire meets Table 6.1.3.4–1. **[SSP 57000C, paragraph 3.3.6.1.6.1]**

6.1.3.4.1.6.2 Differential Characteristic Impedance

The ISPR Differential Characteristic Impedance shall meet the requirements specified in section 14.4.2.2 of ISO/IEC 8802–3 with the exception that the wire meets Table 6.1.3.4–1. **[SSP 57000C, paragraph 3.3.6.1.6.2]**

6.1.3.4.1.6.3 Medium Timing Jitter

The ISPR Medium Timing Jitter will meet the requirements specified in paragraph 14.4.2.3 of ISO/IEC 8802–3 with the exception that the wire meets Table 6.1.3.4–1. **[SSP 57000C, paragraph 3.3.6.1.6.3]**

6.1.3.5 High Rate Data Link (HRDL)

6.1.3.5.1 Payload to High Rate Frame Multiplexer (HRFM) Protocols

The HRF rack shall use the HRFM common protocols in accordance with paragraph 3.3.2, HRFM Protocols of SSP 50184. **[SSP 57000C, paragraph 3.3.7.1]**

6.1.3.5.2 HRDL Interface Characteristics

6.1.3.5.2.1 Physical Signaling

Physical signaling of the HRDL will be in accordance with section 3.0, Performance Requirements of SSP 50184. **[SSP 57000C, paragraph 3.3.7.2.1]**

6.1.3.5.2.2 Encoding

HRF racks using the HRDL shall encode the data in accordance with paragraph 3.1.3, Encoding, including both 3.1.3.1, Data and Symbol Encoding and Table 3.1.3.1–1, 4B/5B NRZI Encoding, and 3.1.3.2 Special Symbol Encoding of SSP 50184. **[SSP 57000C, paragraph 3.3.7.2.2]**

6.1.3.5.2.3 Symbols Used in Testing

HRF racks using the HRDL shall provide the Halt symbol (H) in accordance with Table 3.1.3.1–1, 4B/5B NRZI Encoding in SSP 50184 for use in optical power tests. **[SSP 57000C, paragraph 3.3.7.2.3]**

6.1.3.5.3 HRF Rack HRDL Optical Power

6.1.3.5.3.1 HRF Rack HRDL Transmitted Optical Power

A. HRF racks that transmit data on the HRDL, with or without an ARIS adapter, shall be designed to transmit a HRDL signal in accordance with 3.1.1, Transmitter Optical Characteristics of SSP 50184 at an average optical power greater than –16.25 dBm and less than –8.3 dBm. **[SSP 57000C, paragraph 3.3.7.3.1]**

B. HRF rack transmitted optical power shall be measured at the HRF rack P7 connector to the ISPR connector interface panel using the Halt symbol. **[SSP 57000C, paragraph 3.3.7.3.1]**

6.1.3.5.3.2 HRF Rack HRDL Received Optical Power

A. HRF racks that receive data on the HRDL, with or without an ARIS adapter, shall be designed to receive a HRDL signal in accordance with 3.1.2, Received Optical Characteristics of SSP 50184 at an average optical power greater than –29.95 dBm and less than –8.5 dBm. **[SSP 57000C, paragraph 3.3.7.3.2]**

B. HRF rack received optical power shall be measured at the HRF rack P7 connector to the ISPR connector interface panel using the Halt symbol. **[SSP 57000C, paragraph 3.3.7.3.2]**

6.1.3.5.4 HRDL Fiber Optic Cable

HRF racks shall use fiber optic cable in accordance with SSQ 21654. **[SSP 57000C, paragraph 3.3.7.4]**

6.1.3.5.5 HRDL Fiber Optic Cable Bend Radius

HRF racks shall develop the routing, installation and handling procedures to assure the minimum bend radius of 2 inches or greater is maintained at all times for the Fiber Optic Cable. **[SSP 57000C, paragraph 3.3.7.5]**

6.1.3.5.6 HRDL Connectors And Fiber

A. HRF rack connector P7 mating requirement to the UIP connector J7 is specified in paragraph 6.1.1.6, E. **[SSP 57000C, paragraph 3.3.7.6.A] [note: see Table 6.1.1.6-1 row E in this document]**

B. HRF rack connector P7 shall meet the pin out interfaces of the UIP J7 connector as specified in SSP 57001, paragraph 3.3.4.1. **[SSP 57000C, paragraph 3.3.7.6.B]**

C. HRF rack HRDL connector P7 shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.3.7.6.C]**

D. HRF rack HRDL fiber shall meet the requirements of SSQ 21654 or equivalent. **[SSP 57000C, paragraph 3.3.7.6.D]**

6.1.3.5.7 Payload Laptop

The Payload Laptop is a rack unique laptop which is provided by the Payload Developer (PD). The primary purpose of the Payload Laptop is to provide rack and experiment control and display. Requirements for the Payload Laptop are detailed below.

A. Payload racks which require a laptop shall utilize an IBM 760XD (model 9546U9E) laptop per JSC 27337, Project Technical Requirements Specification (PTRS) Portable Computer System (PCS). **[SSP 57000C, paragraph 3.3.8.1.A]**

B. Payload Laptops shall utilize a Windows NT 4.0 software load supporting the following standard services (Computer Browser, Internet Info Server 4.0, TCP/IP Printing, NetBIOS Interface, Network Monitor & Tools, RPC Config, Server, Transaction Server, Workstation) with TCP/IP Protocol suite. **[SSP 57000C, paragraph 3.3.8.1.B]**

C. Payload Laptop displays shall be in accordance with SSP 50313, Display and Graphical Commonality Standard. **[SSP 57000C, paragraph 3.3.8.1.C]**

D. Each rack shall be limited to one Payload Laptop computer. **[SSP 57000C, paragraph 3.3.8.1.D]**

E. The Payload Laptop shall interface to the rack via a front panel connection utilizing the connectors as specified in Table 6.1.3.5.7-1 and pin outs per SSP 57001, Figures 3.3.6.1–1 through 3.3.6.1–4. **[SSP 57000C, paragraph 3.3.8.1.E]**

F. Data / power cables shall be per design specified in drawings shown in Figure 6.1.3.5.7-1. **[SSP 57000C, paragraph 3.3.8.1.F]**

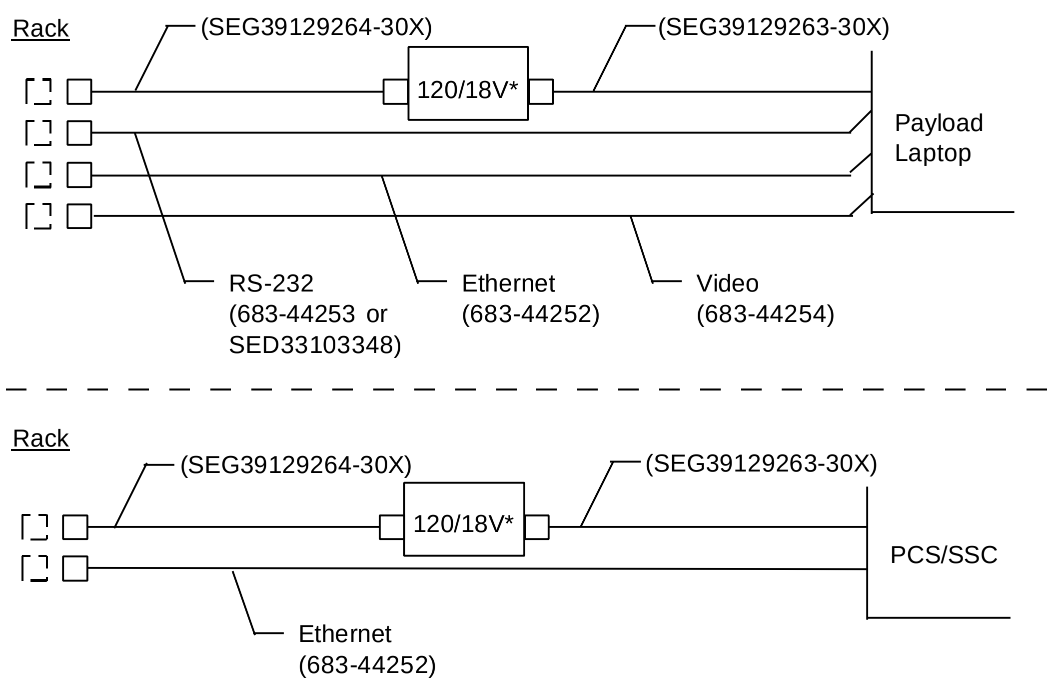
G. A 28V power converter, shown in Figure 6.1.3.5.7-1, shall be per design specified in drawing SED39126010–305. **[SSP 57000C, paragraph 3.3.8.1.G]**

H. The Payload Laptop shall be attached to the rack seat track via the multi–use bracket, SEG33107631–301 and PGSC desk, Shuttle P/N SED33108703–302 or equivalent. **[SSP 57000C, paragraph 3.3.8.1.H]**

TABLE 6.1.3.5.7-1. RACK CONNECTOR NUMBERS

Power	MS3474L14-12S
RS-232	MS27468T15F35SA
Ethernet	MS27468T11F35S
Video	BJ76

[SSP 57000C, TABLE 3.3.8.1-1]



* 16-20V

[SSP 57000C, FIGURE 3.3.8.1-1]

Figure 6.1.3.5.7-1. Data/Power Cable Design

6.1.3.5.8 PCS

A. All payload software to be used on PCS shall adhere to the PCS Interface Definition Document (IDD), SSP 52052. **[SSP 57000C, paragraph 3.3.8.2.A]**

B. PCS displays shall be in accordance with SSP 50313, Display and Graphical Commonality Standard. (not unique to PCS) **[SSP 57000C, paragraph 3.3.8.2.B]**

C. The HRF rack shall be limited to one shared PCS. The PCS is not dedicated to a rack; memory and hard drive availability for payload displays and software must be negotiated with the Payload Software Control Panel. **[SSP 57000C, paragraph 3.3.8.2.C]**

6.1.3.6 Maintenance Switch, Smoke Detector, Smoke Indicator, and HRF Rack Fan Interfaces

6.1.3.6.1 Maintenance Switch Interfaces

The HRF rack power off command interface characteristics shall be in accordance with Table 6.1.3.6–1, Bi-Level Data Characteristics (Switch Contact). **[SSP 57000C, paragraph 3.3.10.1]**

TABLE 6.1.3.6–1. BI-LEVEL DATA CHARACTERISTICS (SWITCH CONTACT)

PARAMETER	ENG. UNIT	ISPR
Type Transfer		Floating (Isolation resistance > 1MΩ) DC coupled
I/F Resistance (closed)	Ω	< 20
I/F Resistance (open)	MΩ	> 1
Open Circuit Leakage Current	μA	0 to 100
Operating Current (closed)	mA	0.2 to 30
Minimum Open Circuit Voltage	V	20

[SSP 57000C, TABLE 3.3.10.1–1]

6.1.3.6.2 Smoke Detector Interfaces

The smoke detector interface consists of:

1. 1 analog obscuration signal from HRF racks to the module
2. 1 analog scatter signal from HRF racks ISPR to the module
3. 1 discrete built-in-test (BIT) command from module to HRF racks.

The analog data monitoring interface characteristics will be as described in paragraph 6.1.3.6.2.1, Analog Interface Characteristics.

The discrete BIT command interface characteristics will be as described in paragraph 6.1.3.6.2.2 Discrete Command Interface Characteristics. The electrical power is supplied to the smoke detector from the rack internal power distribution.

6.1.3.6.2.1 Analog Interface Characteristics

The electrical characteristics (signal source) of the active driver interface shall be in accordance with Table 6.1.3.6–2, Electrical Characteristics Envelope of Analog Signals. **[SSP 57000C, paragraph 3.3.10.2.1]**

TABLE 6.1.3.6–2. ELECTRICAL CHARACTERISTICS ENVELOPE OF ANALOG SIGNALS

PARAMETER	ENG. UNIT	ANALOG SIGNALS
TYPE	N/A	Balanced
TRANSFER	N/A	DC Coupled
ANALOG VOLTAGE (line to line)	V	-5 to +5
RIPPLE AND NOISE	mV Peak (1)	± 20
CAPACITY (Maximum)	nF	N/A
IMPEDANCE	Ohm	≤ 1K
OVERVOLTAGE PROTECTION (Min)	V	± 15
FAULT VOLTAGE EMISSION (Max)	V	± 15
FAULT CURRENT LIMIT (Maximum)	mA	± 10 (2)

Note: (1) Measurement Bandwidth ≥ 50 Mhz
(2) ISPR AAA= 30mA Max

[SSP 57000C, TABLE 3.3.10.2.1–1]

6.1.3.6.2.2 Discrete Command Built-In-Test Interface Characteristics

The discrete command BIT interface characteristics (signal source) shall be in accordance with Table 6.1.3.6–3, Electrical Characteristics of BIT Interface. **[SSP 57000C, paragraph 3.3.10.2.2]**

TABLE 6.1.3.6–3. ELECTRICAL CHARACTERISTICS OF THE BIT INTERFACE

PARAMETER	ENG. UNIT	SMOKE SENSOR
TYPE	N/A	Single ended
TRANSFER	N/A	DC Coupled
I/F VOLTAGE (TRUE) (line to line)	V	< 1.5
OPERATING CURRENT ON (TRUE) (Max)	mA	2
RIPPLE AND NOISE	mV Peak (1)	± 100
FAULT VOLTAGE EMISSION (Max)	V	± 5
FAULT CURRENT EMISSION (Max)	mA	5

Notes: (1) Measurement Bandwidth ≥50 MHz

(2) If interface is active (on or true)

[SSP 57000C, TABLE 3.3.10.2.2–1]

6.1.3.6.2.3 Smoke Indicator Electrical Interfaces

The smoke indicator electrical interface characteristics shall be in accordance with Table 6.1.3.6-4, Smoke Indicator Interface Characteristics. **[SSP 57000C, paragraph 3.3.10.2.3]**

TABLE 6.1.3.6-4. SMOKE INDICATOR INTERFACE CHARACTERISTICS

PARAMETER	ENG. UNIT	SMOKE INDICATOR
TYPE	N/A	Floating
TRANSFER	N/A	DC Coupled
LOAD CURRENT (Max)	mA	10
OVERVOLTAGE PROTECTION RANGE	V	± 20
FAULT CURRENT EMISSION (Max)	mA	24
IMPEDANCE (DC)	Ohm	> 650

Note: At zero current rating (infinite load impedance)

[SSP 57000C, TABLE 3.3.10.2.3-1]

6.1.3.6.2.4 FAN VENTILATION STATUS ELECTRICAL INTERFACES

The HRF rack fan ventilation status electrical interface characteristics shall be in accordance with paragraph 6.1.3.6.2.1, Analog Interface Characteristics. The air is circulated through the smoke sensor in the HRF rack by a fan controlled and powered by the HRF rack. **[SSP 57000C, paragraph 3.3.10.2.4]**

6.1.3.6.3 HRF Rack Power Removal Switch/Fire Detection Support Interface Connector

A. HRF rack connector P43 mating requirements to the UIP connector J43 are specified in paragraph 6.1.1.6, G. **[SSP 57000C, paragraph 3.3.10.3.A] [note: see Table 6.1.1.6-1 row G in this document]**

B. The HRF rack power removal switch/FDS P43 connector shall meet the pin out interfaces of the UIP J43 connector as specified in SSP 57001, paragraph 3.3.6. **[SSP 57000C, paragraph 3.3.10.3.B]**

C. HRF rack power removal switch/FDS P43 connector shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.3.10.3.C]**

6.1.4 <u>Payload NTSC Video Interface Requirements</u>

This paragraph is limited to internal video interfaces. The US LAB and APM provides a fiber optic video interface in accordance with paragraph 6.1.4.2, National Television Standards/System Committee (NTSC) Fiber Optic Video. The JEM provides an NTSC electrical video interfacing accordance with paragraph 6.1.4.3, NTSC Electrical Video Interface. The MPLM does not have video.

6.1.4.1 Payload NTSC Video Characteristics

A. Payload NTSC video characteristics shall be in accordance with Table 6.1.4.1–1, NTSC Video Performance Characteristics. **[SSP 57000C, paragraph 3.4.1.1.A]**

B. The interpretation shall be in accordance with EIA/TIA RS–250–C End to End NTSC Video for Satellite Transmission System. **[SSP 57000C, paragraph 3.4.1.1.B]**

C. Video signal to crosstalk noise, shall be in accordance with paragraph 3.19 of NTC–7. **[SSP 57000C, paragraph 3.4.1.1.C]**

TABLE 6.1.4.1–1. NTSC VIDEO PERFORMANCE CHARACTERISTICS

Characteristic	End-to-End Path Characteristics	Test Method
Amplitude vs. Frequency	10 KHz to 300 KHz ±0.2 dB at 3.58 MHz ± 300 KHz ±0.4 dB to 4.2 MHz ±0.7 dB (A) to 10 Mhz: + 1/-3 dB	EIA/TIA - 250C Para 6.1.1
Chrominance to Luminance Delay Inequality	±4.0 IRE units	EIA/TIA - 250C Para 6.1.2.1
Chrominance to Luminance Delay Inequality	±26 ns	EIA/TIA - 250C Para 6.1.2.2
Field Time Waveform Distortion	3 IRE units peak-to-peak	EIA/TIA - 250C Para 6.1.4
Line Time Waveform Distortion	1 IRE until peak-to-peak	EIA/TIA - 250C Para 6.1.5
Short Time Waveform Distortion	2.0%	EIA/TIA - 250C Para 6.1.1
Long Time Waveform Distortion	8 IRE units overshoot Max. Setting to 5 IRE units after 3 Sec.	EIA/TIA - 250C Para 6.1.7
Line-By-Line DC Offset	±2.0 IRE Max.	
Insertion Gain and Variation	±0.2 dB	EIA/TIA - 250C Para 6.1.8
Luminance Non-Linearity	6% Max	EIA/TIA - 250C Para 6.2.1
Differential Gain	4% Max	EIA/TIA - 250C Para 6.2.2.1
Differential Phase	1.9 degrees	EIA/TIA - 250C Para 6.2.2.2
Chrominance to Luminance Intermodulation	2.0 IRE	EIA/TIA - 250C Para 6.2.3
Chrominance Non-Linear Gain	2.0 IRE	EIA/TIA - 250C Para 6.2.4.1
Chrominance Non-Linear Phase	2.0 degrees	EIA/TIA - 250C Para 6.2.4.2
Dynamic Gain of the Picture Signal	4.0 IRE	EIA/TIA - 250C Para 6.2.5.1
Dynamic Gain of the Synchronizing Signal	2.0 IRE	EIA/TIA - 250C Para 6.2.5.2
Transient Synchronizing Signal Non-Linearity	3.0 IRE	EIA/TIA - 250C Para 6.2.6
Signal to Noise Ratio (10 KHz to MHz) (Triangular)	43.8 dB min, unweighted	EIA/TIA - 250C Para 6.3.1
Signal to Noise Ratio (10 KHz to 10 KHz) (Triangular)	36.6 dB min, unweighted	EIA/TIA - 250C Para 6.3.1
Signal to Low Frequency Noise (0-10 KHz)	50 dB min, unweighted	EIA/TIA - 250C Para 6.3.2
Signal to Periodic Noise Ratio (300 Hz to 4.2 MHz)	63 dB min, unweighted	EIA/TIA - 250C Para 6.3.3
2T Short Time Distortion	±4.0 IRE units	NTC-7 Para 3.5
Group Delay (5 to 10 MHz)	150 ns	

Note: (A) Monotonic roll off beyond 4.2 Min Mhz.

[SSP 57000C, TABLE 3.4.1.1–1]

6.1.4.2 NTSC Fiber Optic Video

6.1.4.2.1 Pulse Frequency Modulation NTSC Fiber Optic Video Characteristics

The Pulse Frequency Modulation (PFM) fiber optical video interface consists of one video channel into the rack, one video channel out of the rack, and one synchronization and control channel.

A. The PFM fiber optic video shall be in accordance with paragraph 6.1.4.1, Payload NTSC Video Characteristics. **[SSP 57000C, paragraph 3.4.1.2.1.A]**

B. The PFM fiber optic characteristics shall in accordance with Table 6.1.4.2–1, NTSC Fiber Optic Video Signal Characteristics. **[SSP 57000C, paragraph 3.4.1.2.1.B]**

TABLE 6.1.4.2–1. NTSC FIBER OPTIC VIDEO SIGNAL CHARACTERISTICS

PFM Signal Bandwidth	40-72 Megahertz (MHz)
PFM Signal Characteristics	Square wave, FM signal characterized by nominal 50 percent duty cycle
PFM Center Frequency (Blanking Level)	48.57 MHz (0 IRE/0 mV)
White Level Frequency	70.25 MHz (100 IRE/-714 mV)
Sync Tip Frequency	40.07 MHz (-40 IRE/-286 mV)
Blanking Level Variation	±2 MHz
Video Signal Format	NTSC composite NTSC/EIA-RSA-170A (1)
Pre-emphasis/De-emphasis	per CCIR Recommendation 405 of EIA/TIA-250-C.(1) (2)
Bus Media	Fiber Optics on both SSMB and APM sides
Video Sync	EIA-RS-170A Compliant Black Burst Sync

Notes:

(1) Or any video/data format compatible with PFM characteristics as indicated in this Table.

(2) With the emphasis enabled the above set-up results in PFM frequencies of 53.27 MHz for the white level (100 IRE/714 mV), 48.57 MHz for the blanking level (0 IRE/0 mV), and 46.67 MHz for sync tip (-40 IRE/-286 mV).

[SSP 57000C, TABLE 3.4.1.2–1]

6.1.4.2.2 HRF Rack NTSC PFM Video Transmitted Optical Power

The HRF rack that transmits PFM video on the optical video system, with or without an ARIS adapter, shall be designed to transmit a video PFM signal at an average optical power greater than –15.5 dBm. **[SSP 57000C, paragraph 3.4.1.2.2]**

6.1.4.2.3 HRF Rack NTSC PFM Video and Sync Signal Received Optical Power

The HRF rack that receives PFM video and sync signal on the optical video system, with or without an ARIS adapter, shall be designed to receive a PFM video and sync signal at an average optical power greater than –22.2 dBm. **[SSP 57000C, paragraph 3.4.1.2.3]**

6.1.4.2.4 Fiber Optic Cable Characteristics

The video/data and sync signals shall use fiber optic cable in accordance with Table 6.1.4.2–2, PFM NTSC Video Optical Fiber Characteristics. **[SSP 57000C, paragraph 3.4.1.2.4]**

TABLE 6.1.4.2-2. PFM NTSC VIDEO OPTICAL FIBER CHARACTERISTICS

Parameter	**Dim.**	**Medium Characteristics**
Operating Wave Length (min/max)	nm	1270/1380
Fiber Type	-	graded index, multimode
Fiber Core Diameter (min/max)	mm	98/102
Fiber Cladding Diameter (min/max)	mm	138/142
Numerical Aperture (min/max)	-	0.28/0.32
Attenuation @ 1290 ± 10nm	dB/Km	≤ 4
Modal Bandwidth @ 1290 ± 10nm	Mhz x Km	200
-Signal Timing:		
Optical Rise Time (10% to 90%)	ns	≤ 3.5
Optical Fall Time (10% to 90%)	ns	≤ 3.5
Random Jitter (peak-to-peak) (1)	ns	≤ 0.76
Data Dependent Jitter (peak-to-peak) (1)	ns	≤ 0.6
Duty Cycle Distortion (peak-to-peak) (1)	ns	≤ 1

Note:
(1) These parameters refer to fiber optic data test setup.

[SSP 57000C, paragraph 3.4.1.2.4]

6.1.4.2.5 PFM NTSC Video Fiber Optic Cable Bend Radius

The HRF rack shall develop the routing, installation and handling procedures to assure the minimum bend radius of 2 inches or greater is maintained at all times for the Fiber Optic Cable. **[SSP 57000C, paragraph 3.4.1.2.5]**

6.1.4.2.6 PFM NTSC Optical Connector/Pin Assignments

A. HRF rack connector P16 mating requirements to the UIP connector J16 are specified in paragraph 6.1.1.6, F. **[SSP 57000C, paragraph 3.4.1.2.7.A] [note: see Table 6.1.1.6-1 row F in this document]**

B. The HRF rack PFM NTSC video fiber optic system P16 connector shall meet the pin out interfaces of the UIP J16 connector as specified in SSP 57001, paragraph 3.4.1.2. **[SSP 57000C, paragraph 3.4.1.2.7.B]**

C. The HRF rack PFM NTSC video fiber optic system P16 connector shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.4.1.2.7.C]**

6.1.4.3 NTSC Electrical Video Interfaces

6.1.4.3.1 NTSC Electrical Video Characteristics

TBD

6.1.4.4 NTSC Electrical Connector/Pin Assignments

A. HRF rack connector P77 mating requirements to the ISPR UIP connector J77 are specified in paragraph 6.1.1.6, K. **[SSP 57000C, paragraph 3.4.1.4.A] [note: see Table 6.1.1.6-1 row K in this document]**

B. The HRF rack PFM NTSC video fiber optic system P77 connector shall meet the pin out interfaces of the UIP J77 connector as specified in SSP 57001, paragraph 3.4.2.1. **[SSP 57000C, paragraph 3.4.1.4.B]**

C. The HRF rack PFM NTSC video fiber optic system P77 connector shall meet the requirements of SSQ 21635 or equivalent. **[SSP 57000C, paragraph 3.4.1.4.C]**

6.1.5 <u>Thermal Control Interface Requirements</u>

6.1.5.1 MTL Physical Interface

HRF racks connectors for the Moderate Temperature Loop (MTL) water cooling supply and return mating requirements to the utility interface panel connectors are specified in paragraph 6.1.1.6, items L and M. **[SSP 57000C, paragraph 3.5.1.1.A] [note: see Table 6.1.1.6-1 rows L and M in this document]**

6.1.5.2 Internal Thermal Control System (ITCS) Fluid Use and Charging

A. ITCS Fluid Use

Coolant contained in the HRF rack that interfaces with ITCS coolant shall satisfy the cleanliness and materials requirements specified in paragraph 6.1.11.2. **[SSP 57000C, paragraph 3.5.1.2.A]**

B. HRF Rack Charging

Payloads shall be delivered on-orbit charged with coolant as specified in paragraph 6.1.11.2 and during transport, HRF racks that are not actively serviced by the MPLM Thermal Control System during transport shall be charged to allow for thermal expansion between the temperature of 1.67 °C (35 °F) and 46 °C (114.8 °F). **[SSP 57000C, paragraph 3.5.1.2.B]**

6.1.5.3 ITCS Pressure Drop

The HRF rack shall be designed to meet the moderate temperature loop pressure drop specified in paragraph 3.5.1.2 of the Pressurized Payload Hardware Interface Control Document, SSP 57001. **[SSP 57000C, paragraph 3.5.1.3.A]**

6.1.5.4 MTL Coolant Flow Rate

The HRF rack shall be designed to meet the moderate temperature loop allowable flow rate specified in paragraph 3.5.1.3 of the Pressurized Payload Hardware Interface Control Document, SSP 57001. **[SSP 57000C, paragraph 3.5.1.4.A]**

6.1.5.5 MTL Coolant Supply Temperature

The HRF rack shall be designed to meet the moderate temperature loop coolant supply temperature specified in paragraph 3.5.1.4 of the Pressurized Payload Hardware Interface Control Document, SSP 57001. **[SSP 57000C, paragraph 3.5.1.5.A]**

6.1.5.6 MTL Coolant Return Temperature

A. HRF racks connected to the MTL shall provide a delta temperature from the inlet to the outlet of the rack of 25.5 °F to 27.5 °F at operating modes above 1300 W at 65 °F inlet temperature. **[SSP 57000C, paragraph 3.5.1.6.A as modified by approved PIRN 57200NA0001]**

B. HRF racks connected to the MTL shall not exceed a maximum flow rate of 160 lbm/hr for operating modes below 1300W as shown in Figure 6.1.5.6-1. **[SSP 57000C, paragraph 3.5.1.6.B as modified by approved PIRN 57200NA0001]**

C. The maximum moderate temperature coolant return temperature shall be no greater than 49 °C (120 °F). **[SSP 57000C, paragraph 3.5.1.6.C]**

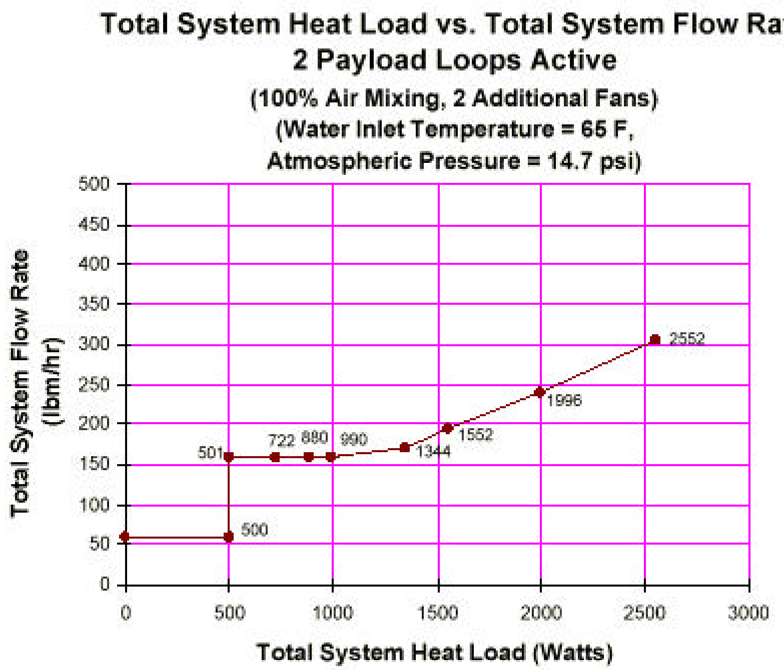


Figure 6.1.5.6-1. HRF Rack Heat Load vs. Flow Rate

6.1.5.7 MTL Coolant Maximum Design Pressure

The HRF rack liquid cooling system shall withstand the moderate temperature loop maximum design pressure of 121 psia (834 kPa). **[SSP 57000C, paragraph 3.5.1.7.A]**

6.1.5.8 Fail Safe Design

The HRF racks shall assess the rack equipment and rack internal water loop piping to ensure that it is fail safe in the case of loss of cooling under all modes of operation. **[SSP 57000C, paragraph 3.5.1.8]**

6.1.5.9 Leakage

Leakage rates must be determined at the integrated rack level for a launch package.

6.1.5.10 Quick-Disconnect Air Inclusion

HRF rack Quick Disconnects shall not exceed the maximum air inclusion of .30 cubic centimeters (cc) maximum per mate or demate operation. **[SSP 57000C, paragraph 3.5.1.10]**

6.1.5.11 Rack Front Surface Temperature

HRF racks shall be designed such that the maximum front surface temperature does not exceed 45 °C (113 °F). **[SSP 57000C, paragraph 3.5.1.11]**

Average front surface temperature must be determined at the integrated rack level for a launch package.

6.1.5.12 Cabin Air Heat Leak

Cabin air heat leak must be determined at the integrated rack level for a launch package.

6.1.5.13 Control System Time Constant

HRF rack automated flow control systems shall be designed such that set point changes resulting in flow rate changes greater than five pounds mass flow per hour (5 lbm/hr) shall take at least 100 seconds to reach 63.2% (i.e., $1 - e^{-1}$) of the commanded change in flow rate. **[SSP 57000C, paragraph 3.5.1.15]**

6.1.5.14 Payload Coolant Quantity

HRF racks shall contain no more than the maximum allowable coolant quantity of water, referenced at 61 °C (141.8 °F), as specified in paragraph 3.5.1.7 of the Pressurized Payload Hardware Interface Control Document SSP 57001. **[SSP 57000C, paragraph 3.5.1.16]**

6.1.5.15 Payload Gas Inclusion

HRF racks shall not exceed the maximum allowable gas inclusion or volume at the maximum design pressure into the Internal Thermal Control System as specified in paragraph 3.5.1.8 of the Pressurized Payload Hardware Interface Control Document SSP 57001. **[SSP 57000C, paragraph 3.5.1.17]**

6.1.6 Vacuum System Requirements

6.1.6.1 Vacuum Exhaust System Requirements

6.1.6.1.1 VES Physical Interface

HRF racks connectors for the Vacuum Exhaust System (VES) mating requirements to the UIP connectors are specified in paragraph 6.1.1.6, Q. **[SSP 57000C, paragraph 3.6.1.1] [note: see Table 6.1.1.6-1 row Q in this document]**

6.1.6.1.2 Input Pressure Limit

HRF rack volumes connected to the VES shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3. **[SSP 57000C, paragraph 3.6.1.2.B]**

6.1.6.2 Vacuum Resource System Requirements

6.1.6.2.1 VRS Physical Interface

HRF rack connectors for the Vacuum Resource System (VRS) mating requirements to the UIP connectors are specified in paragraph 6.1.1.6, R. **[SSP 57000C, paragraph 3.6.2.1] [note: see Table 6.1.1.6-1 row R in this document]**

6.1.6.2.2 Input Pressure Limit

HRF rack volumes connected to the VRS shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3. **[SSP 57000C, paragraph 3.6.2.2.B]**

6.1.7 <u>Pressurized Gases Interface Requirements</u>

6.1.7.1 Nitrogen Interface MDP

The MDP of the HRF rack nitrogen system shall be 1,379 kPa (200 psia). **[SSP 57000C, paragraph 3.7.1.2]**

6.1.7.2 Nitrogen Interface Temperature

The HRF rack nitrogen system shall be designed for a nitrogen supply temperature range of 15.6 °C to 45 °C (60 °F to 113 °F). **[SSP 57000C, paragraph 3.7.1.3]**

6.1.7.3 Nitrogen Leakage

Nitrogen leakage must be determined at the integrated rack level for a launch package.

6.1.7.4 Nitrogen Interface Connection

HRF rack connectors for the nitrogen system mating requirements to the UIP connectors are specified in paragraph 6.1.1.6, P. **[SSP 57000C, paragraph 3.7.1.5] [note: see Table 6.1.1.6-1 row P in this document]**

6.1.8 Fluid System Servicer

The HRF rack shall meet the physical and functional interfaces depicted in Figure 1 of the Fluid System Servicer (FSS) Interface Definition Drawing (IDD), 683-17103. **[SSP 57000C, paragraph 3.8.2]**

6.1.9 Environment Interface Requirements

6.1.9.1 Atmosphere Requirements

6.1.9.1.1 Pressure

The HRF rack shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia). **[SSP 57000C, paragraph 3.9.1.1]**

6.1.9.1.2 Temperature

The HRF rack shall be safe when exposed to temperatures of 10 to 46 °C (50 to 115 °F). **[SSP 57000C, paragraph 3.9.1.2]**

6.1.9.1.3 Humidity

The HRF rack shall be designed to not cause condensation when exposed to a dewpoint of 4.5 to 15.6 °C (40 to 60 °F) and a relative humidity of 25 to 75% except when condensation is an intended operation of the HRF rack. **[SSP 57000C, paragraph 3.9.1.3]**

6.1.9.2 Integrated Rack Use of Cabin Atmosphere

6.1.9.2.1 Active Air Exchange

Active air exchange with the cabin atmosphere by the HRF rack shall be limited to air exchange for specimen metabolic purposes and for mass conservation purposes. **[SSP 57000C, paragraph 3.9.2.1.A]**

6.1.9.2.2 Oxygen Consumption

The HRF rack shall not consume oxygen from cabin air. **[Sub-allocation of SSP 57000B, paragraph 3.9.2.2]**

6.1.9.2.3 Chemical Releases

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.9.2.3]**

6.1.9.3 Ionizing Radiation Requirements

6.1.9.3.1 HRF Rack Contained or Generated Ionizing Radiation

HRF racks containing or using radioactive materials or that generate ionizing radiation shall comply with NSTS 1700.7B, ISS Addendum, paragraph 212.1. **[SSP 57000C, paragraph 3.9.3.1]**

6.1.9.3.2 Ionizing Radiation Dose

HRF racks should expect a total dose (including trapped protons and electrons) of 30 Rads(Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC–TN–9550) may show ionizing radiation exposure to be different than 30 Rads(Si) per year, if the intended location of the rack in the ISS is known.

6.1.9.3.3 Single Event Effect (SEE) Ionizing Radiation

Equipment and subsystems shall be designed not to produce an unsafe condition or one that could cause damage to equipment external to the HRF rack as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils). **[SSP 57000C, paragraph 3.9.3.3]**

6.1.9.3.4 Additional Environmental Conditions

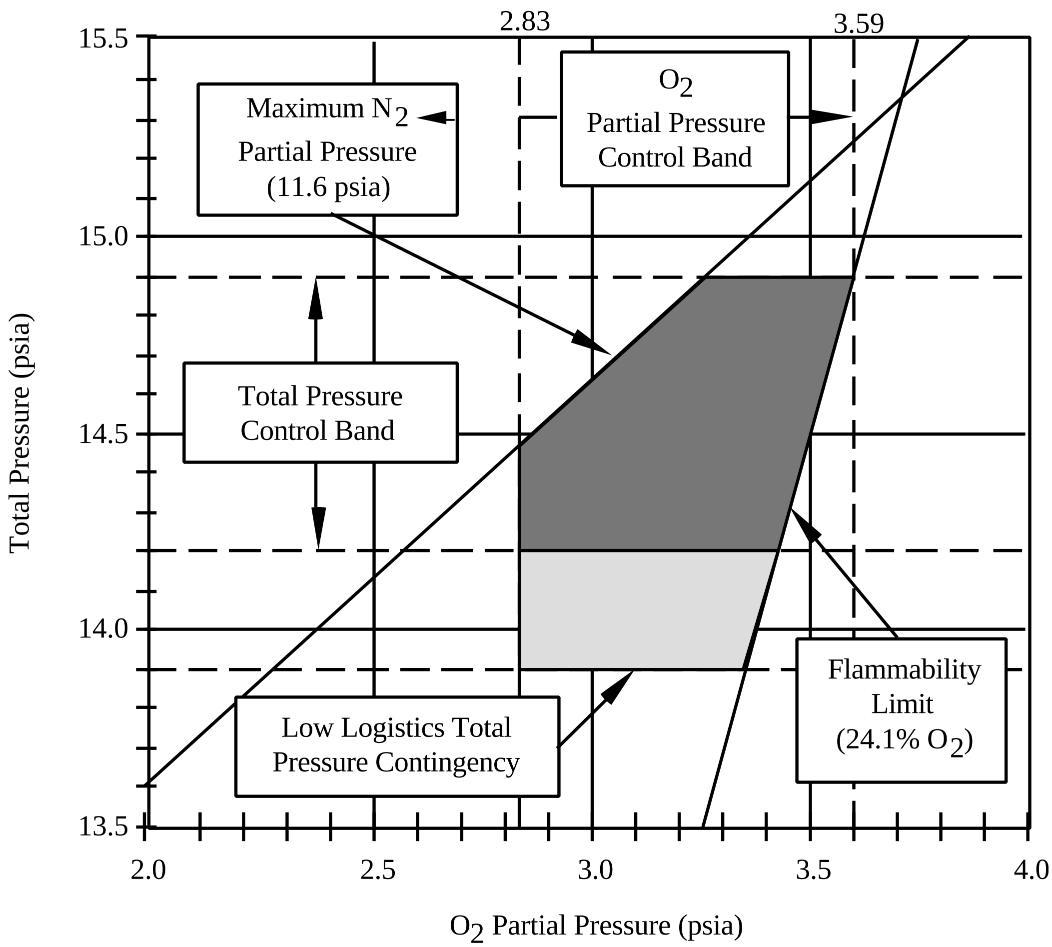
The environmental information provided in Table 6.1.9–1, Environmental Conditions on ISS, is for design and analysis purposes. **[SSP 57000C, paragraph 3.9.3.4]**

TABLE 6.1.9–1. ENVIRONMENTAL CONDITIONS ON ISS

Environmental Condition	Value
Atmospheric Conditions	
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)
Normal operating pressure	See Figure 3.9.3.4-1
Oxygen partial pressure	See Figure 3.9.3.4-1
Nitrogen partial pressure	See Figure 3.9.3.4-1
Dewpoint	4.4 to 15.6 °C (40 to 60 °F)
Percent relative humidity	25 to 75
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mm Hg Peak exposure 10 mm Hg
Cabin air temperature in USL, JEM, APM, and CAM	17 to 28 °C (63 to 82 °F)
Cabin air temperature in Node 1	17 to 31 °C (63 to 82 °F)
Air velocity	0.051 to 2.03 m/s (10 to 40 ft/min)
Airborne microbes	Less than 1000 CFU/m^3
Atmosphere particulate level	Average less than 1000,000 particles/ft^3 for particles less than 0.5 microns in size
MPLM Air Temperatures	**Active Flights**
Pre-Launch	14 to 30 °C (57.2 to 86 °F)
Launch/Ascent	20 to 30 °C (68 to 86 °F)
On-orbit (Cargo Bay + Deployment)	16 to 46 °C (60.8 to 114.8 °F)
On-orbit (On-Station)	16 to 43 °C (63 to 109.4 °F)
On-orbit (Retrieval + Cargo Bay)	11 to 45 °C (63 to 113 °F)
Descent/Landing	10 to 42 °C (50 to 107.6 °F)
Post-Landing	10 to 42 °C (50 to 107.6 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
	Passive Flights
Pre-Launch	15 to 24 °C (59 to 75.2 °F)
Launch/Ascent	14 to 24 °C (57.2 to 75.2 °F)
On-orbit (Cargo Bay + Deployment)	24 to 44 °C (75.2 to 111.2 °F)
On-orbit (On-Station)	23 to 45 °C (73.4 to 113 °F)
On-orbit (Retrieval + Cargo Bay)	17 to 44 °C (62.6 to 111.2 °F)
Descent/Landing	13 to 43 °C (55.4 to 109.4 °F)
Post-Landing	13 to 43 °C (55.4 to 109.4 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
Thermal Conditions	
USL module wall temperature	13 °C to 43 °C (55 °F to 109 °F)
JEM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
APM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
CAM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
Other integrated payload racks	Front surface less than 37 °C (97 °F)
***Microgravity**	
Quasi-Steady State Environment	See Figures 3.9.3.4-2, 3.9.3.4-3 and Table 3.9.3.4-2
Vibro-acoustic Environment	See Figure 3.9.3.4-4
General Illumination	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle

*Note: Data reflects best available information as of May, 1997. Does not include effects of CAM.

[SSP 57000C, TABLE 3.9.4–1]



[SSP 57000C, FIGURE 3.9.4–1]

Figure 6.1.9–1. Operating Limits of the ISS Atmospheric Total Pressure, and Nitrogen and Oxygen Partial Pressures

6.1.10 Fire Protection Interface Requirements

6.1.10.1 Fire Prevention

HRF racks shall meet the fire prevention requirements specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10a. **[SSP 57000C, paragraph 3.10.1]**

6.1.10.2 Payload Monitoring and Detection Requirements

Note: The ISS monitors and detects fire events within payloads containing potential fire sources by using a station approved rack smoke detector. For payload volumes that contain a potential fire source but do not exchange air with the rack smoke detector because there is no forced air circulation, or for metabolic or science isolation purposes, parameter monitoring can be used as an alternative. Use of parameter monitoring will be presented to and approved by the PSRP during the phased safety reviews. Volumes containing no potential fire sources do not require detection capabilities. Small aisle mounted equipment (laptop computers, etc.) may not require detection capabilities. Safety monitoring and detection requirements are specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10b.

6.1.10.2.1 Smoke Detection

6.1.10.2.1.1 Smoke Detector

A. HRF racks that contain potential fire source and have forced air circulation shall use a smoke detector that meets the requirements specified in 683–10007 and SSP 30262:013. **[SSP 57000C, paragraph 3.10.2.1.1.A]**

B. HRF racks requiring a smoke detector shall provide a smoke detector interface at the J43 connection with interface characteristics meeting the requirements specified in paragraph 6.1.3.6. **[SSP 57000C, paragraph 3.10.1.1.B]**

6.1.10.2.1.2 Forced Air Circulation Indication

HRF racks requiring a smoke detector shall provide a signal and data indicating whether or not the air flow specified in SSP 30262:013, paragraph 3.6.6, is being provided to the smoke detector when the smoke detector is in use. **[SSP 57000C, paragraph 3.10.2.1.2]**

6.1.10.2.1.3 Fire Detection Indicator

A. HRF racks requiring a smoke detector shall provide a red Fire Detection Indicator LED in an easily visible location on the front of the rack that is powered by the ISS when the smoke detector senses smoke. **[SSP 57000C, paragraph 3.10.2.1.3.A]**

B. HRF racks requiring a fire detection indicator shall provide a fire detection indicator interface at the J43 connection with interface characteristics meeting the requirements specified in paragraph 6.1.3.6. **[SSP 57000C, paragraph 3.10.2.1.3.B]**

6.1.10.3 Fire Suppression

Note: Each separate HRF rack and sub-rack equipment volume which contains a potential fire source will require fire suppression capabilities. Determination of potential fire sources will be presented to and approved by the PSRP during the phased safety reviews. Safety fire suppression requirements are specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10c.

6.1.10.3.1 Portable Fire Extinguisher

A. HRF rack and sub-rack enclosed volumes that have a panel thickness less than or equal to 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 6.1.1.4–1. **[SSP 57000C, paragraph 3.10.3.1.A]**

B. HRF rack and sub-rack enclosed volumes that have a panel thickness greater than 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 6.1.1.4–1. **[SSP 57000C, paragraph 3.10.3.1.B]**

Note 1: The final determination of whether or not a payload volume contains a potential fire source and requires a PFE access port will be presented to and approved by the PSRP during the phased safety reviews.

Note 2: The ISS PFE has an "open cabin" diffuser nozzle which will be used to surround fire events that are not in an enclosed volume with suppressant.

Note 3: Internal volumes are volumes presented to and approved by the PSRP as sealed containers do not require PFE access ports.

6.1.10.3.2 Fire Suppression Access Port Accessibility

The HRF rack shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figure 6.4.4.1.1-1 so the PFE nozzle can interface to the PFE port**. [SSP 57000C, paragraph 3.10.3.2]**

6.1.10.3.3 Fire Suppressant Distribution

The internal layout of HRF rack shall allow ISS PFE fire suppressant to be distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. Volumes specified in section 6.1.10.3.4 do not apply to this requirement. **[SSP 57000C, paragraph 3.10.3.2]**

Note: The position of integrated rack internal components near the PFE Access Port should not prevent fire suppressant to be discharged into the volume the PFE Access Port serves. PFE discharge characteristics are specified in Figure 6.1.1.4–1 and PFE closed volume nozzle dimensions are specified in Figure 6.4.4.1.1-2 in section 6.4 of this document.

6.1.10.4 Labeling

A. HRF racks requiring an access port shall label the PFE access port with a SDD32100397–002 “Fire Hole Decal” specified in JSC 27260, “Decal Process Document and Catalog”. **[SSP 57000C, paragraph 3.10.4.A]**

B. HRF racks requiring a Fire Detection Indicator LED shall label the Fire Detection Indicator LED “SMOKE INDICATION” as specified in MSFC–STD–275, using 3.96mm (0.156 inch) letters, style Futura Demibold, and color 37038 (Lusterless Black) per FED–STD–595. **[SSP 57000C, paragraph 3.10.4.B]**

6.1.11 Materials and Parts Interface Requirements

6.1.11.1 Materials and Parts Use and Selection

HRF racks shall use materials and parts that meet the materials requirements specified in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.11.1]**

6.1.11.1.1 Commercial Parts

COTS parts used in the HRF rack shall meet the materials requirements specified in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.11.1.1]**

6.1.11.2 Fluids

A. HRF racks which connect to ISS fluid systems shall use fluids that meet the requirements specified in SSP 30573. **[SSP 57000C, paragraph 3.11.2.A]**

B. HRF racks which connect to ISS fluid systems shall meet the fluid system cleanliness levels specified in SSP 30573. **[SSP 57000C, paragraph 3.11.2.B]**

C. HRF racks using ISS aqueous fluid systems shall use internal materials that are compatible according to MSFC–SPEC–250, Table III or that will not create a potential greater than 0.25 Volts with the ISS system internal materials due to a dissimilar metal couple. **[SSP 57000C, paragraph 3.11.2.C]**

6.1.11.3 Cleanliness

HRF racks shall conform to Visibly Clean-Sensitive (VC–S) cleanliness requirements as specified in SN–C–0005. **[SSP 57000C, paragraph 3.11.3]**

6.1.11.4 Fungus Resistant Material

HRF racks that are intended to remain on-orbit for more than one year shall use fungus resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10. **[SSP 57000C, paragraph 3.11.4]**

6.2 ISS DESIGN AND HRF RACK DEPENDENT INSTRUMENT INTERFACE REQUIREMENTS

This section contains ISS design and HRF rack interface requirements for HRF rack dependent instruments. HRF rack dependent instruments are those instruments that use HRF rack SIR drawer interfaces or HRF rack front panel interfaces during primary operations. Instruments with data storage capabilities that require temporary connections to HRF rack power and data interfaces for data transfer before or after primary operations and do not require the HRF rack to be powered at specific intervals are not considered to be HRF rack dependent.

Note: For configuration management purposes, requirement text defined in SSP 57000 is documented here verbatim, with the two exceptions. The terms “integrated rack” or “rack” have been replaced with “rack dependent instruments” for ISS design requirements generically applicable to subrack or rack dependent instruments. Paragraph, figure and table numbers specified in SSP 57000 requirement text that are contained in this document have been changed to conform to the numbering structure of this document. No corrections to spelling, punctuation, first occurrence or use of acronyms have been made.

6.2.1 Structural/Mechanical

Structural requirements are provided for HRF rack SIR drawer and seat track interfaces. Requirements for building a SIR drawer enclosure are not contained in this document, but can be found in the SSP 50321, International Subrack Interface Standards (ISIS) Drawer Specification (ISIS-02).

6.2.1.1 ISS Structural/Mechanical Design Requirements

6.2.1.1.1 Safety Critical Structures

Rack dependent instruments shall be designed in accordance with the requirements specified in SSP 52005. **[SSP 57000C, paragraph 3.1.1.5.A]**

6.2.1.1.2 First Modal Frequency

SIR drawer instruments shall have a first modal frequency of not less than 35 Hz for launch and landing, based on rigidly mounting the instrument at the rack to SIR drawer instrument interface. **[SSP 57000C, paragraph 3.1.1.4.D]**

6.2.1.1.3 Launch and Landing Loads

A. For design and qualification purposes, SIR drawer instruments shall maintain positive margins of safety for the MPLM ascent random vibration environment as defined in Table 6.2.1.1–1, “Random Vibration Criteria for HRF Rack Post Mounted Equipment in the MPLM.” **[SSP 57000C, paragraph 3.1.1.3.E]**

TABLE 6.2.1.1-1. RANDOM VIBRATION CRITERIA FOR HRF RACK POST MOUNTED EQUIPMENT IN THE MPLM

FREQUENCY	LEVEL
20 Hz	0.005 g^2/Hz
20-70 Hz	+5.0 dB/oct
70-200 Hz	0.04 g^2/Hz
200-2000 Hz	-3.9 dB/oct
2000 Hz	0.002 g^2/Hz
Composite	4.4 grms

Note: Criteria is the same for all directions (X, Y, Z)
[SSP 57000C, TABLE 3.1.1.3-2]

B. SIR drawer instruments shall maintain positive margins of safety for the launch and landing conditions in the MPLM. For early design, the acceleration environment defined in Table 6.2.1.1–2, “HRF Rack Mounted Equipment Load Factors (Equipment Frequency 35 Hz)” will be used. These load factors will be superseded by load factors obtained through ISS-performed Coupled Loads Analysis as described in SSP 52005. **[SSP 57000C, paragraph 3.1.1.3.F]**

TABLE 6.2.1.1-2. HRF RACK MOUNTED EQUIPMENT LOAD FACTORS (EQUIPMENT FREQUENCY 35 MHz)

Liftoff (g)	**X** ±7.7	**Y** ±11.6	**Z** ±9.9
Landing (g)	X ±5.4	Y ±7.7	Z ±8.8

Note: Load factors apply concurrently in all possible combinations for each event and are shown in the rack coordinate system.

[SSP 57000C, TABLE 3.1.1.3-3]

6.2.1.1.4 On-Orbit Loads

A. HRF rack dependent instruments shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction. **[SSP 57000C, paragraph 3.1.1.3.B]**

B. HRF rack dependent instruments shall provide positive margins of safety when exposed to the crew-induced loads defined in Table 6.2.1.1–3, Crew-Induced Loads. **[SSP 57000C, paragraph 3.1.1.3.D]**

TABLE 6.2.1.1–3. CREW-INDUCED LOADS

CREW SYSTEM OR STRUCTURE	TYPE OF LOAD	LOAD	DIRECTION OF LOAD
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N-M (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf), limit	Any direction
Cabinets and any normally exposed equipment	Concentrated load applied by flat round surface with an area of (0.093 m^2) (1 ft^2)	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

[SSP 57000C, TABLE 3.1.1.3-1]

6.2.1.1.5 SIR Drawer Front Panel Permanent Protrusions

A. HRF rack mounted SIR drawer instrument front panel permanent protrusions shall be limited to the area between SIR drawer handles.

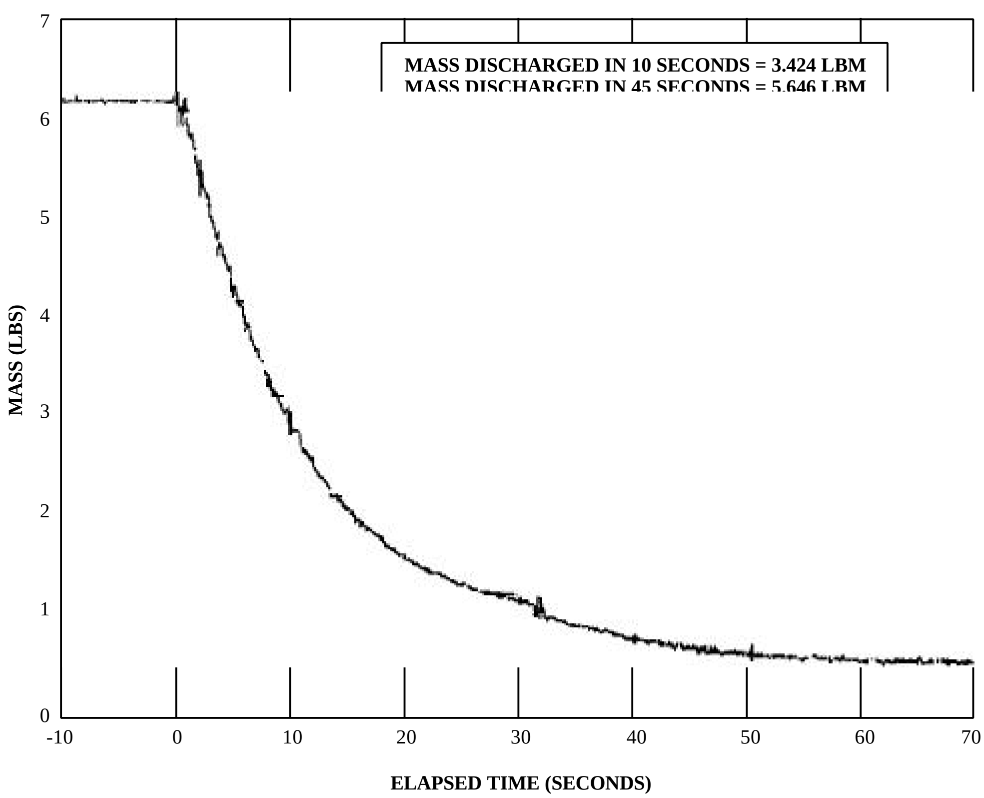
B. HRF rack mounted SIR drawer instrument front panel permanent protrusions shall not extend beyond SIR drawer handles.

6.2.1.1.6 Dynamic Pressure

A. Rack dependent instruments shall maintain positive margins of safety for MPLM depress rates of 890 Pa/second (7.75 psi/minute) and repress rates of 800 Pa/second (6.96 psi/minute). **[SSP 57000C, paragraph 3.1.1.2.B]**

B. Rack dependent instruments shall maintain positive margins of safety for the on-orbit depress/repress rates identified in SSP 41002 paragraph 3.1.7.2.1. **[SSP 57000C, paragraph 3.1.1.4.B]**

C. Rack dependent instruments that have PFE access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 6.2.1.1–1, Manual Fire Suppression System Performance Characteristics. **[SSP 57000C, paragraph 3.1.1.4.K]**



[SSP 57000C, Figure 3.1.1.4-1]

Figure 6.2.1.1–1. Manual Fire Suppression System Performance Characteristics

6.2.1.1.7 Microgravity

Microgravity requirements have not been determined by the ISS Program.

A. Quasi-Steady Requirements

TBD

B. Vibratory Requirements

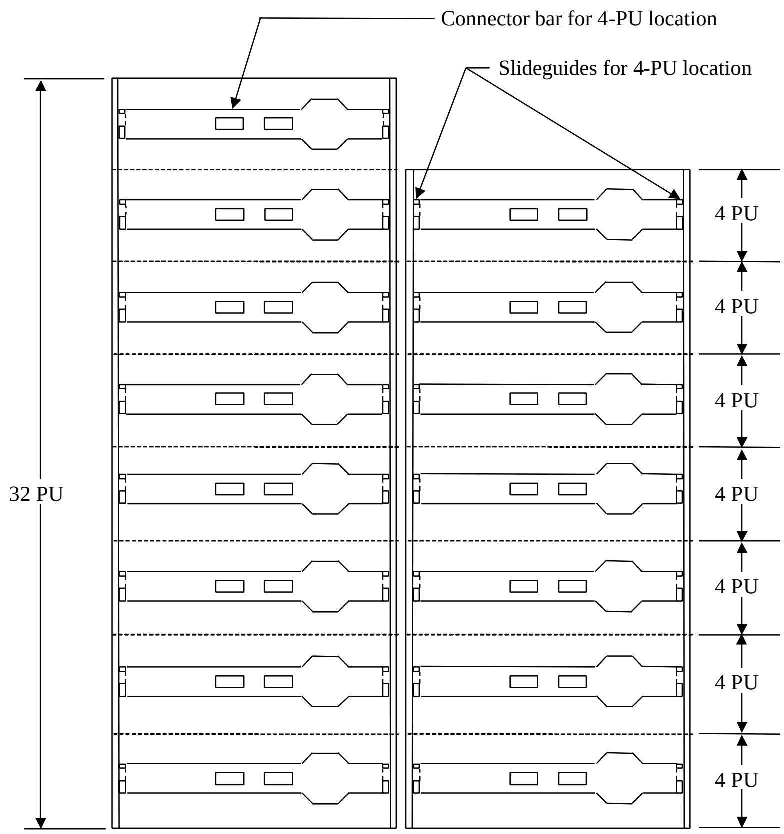
TBD

C. Transient Requirements

TBD

6.2.1.2 HRF Rack to SIR Drawer Structural Interface Requirements

HRF rack SIR drawer accommodations are shown in Figure 6.2.1.2-1.



Note: SIR drawer accommodations viewed from front of the HRF rack.

Figure 6.2.1.2-1. HRF Rack SIR Drawer Accommodations

6.2.1.2.1 Dimensional Tolerances

HRF rack mounted SIR drawer dimensional tolerances shall be in accordance with Table 6.2.1.2-1.

TABLE 6.2.1.2-1. DIMENSIONAL TOLERANCES

English Dimension	Tolerance
X.XX	±0.030
X.XXX	±0.010
Xº	±1º

6.2.1.2.2 SIR Drawer Structural/ Mechanical Interfaces

HRF rack mounted SIR drawers shall interface to the HRF rack through slide guide assemblies consisting of slide guides, striker assemblies, and connector bars in accordance with Figures 6.2.1.2-2 through 6.2.1.2-8.

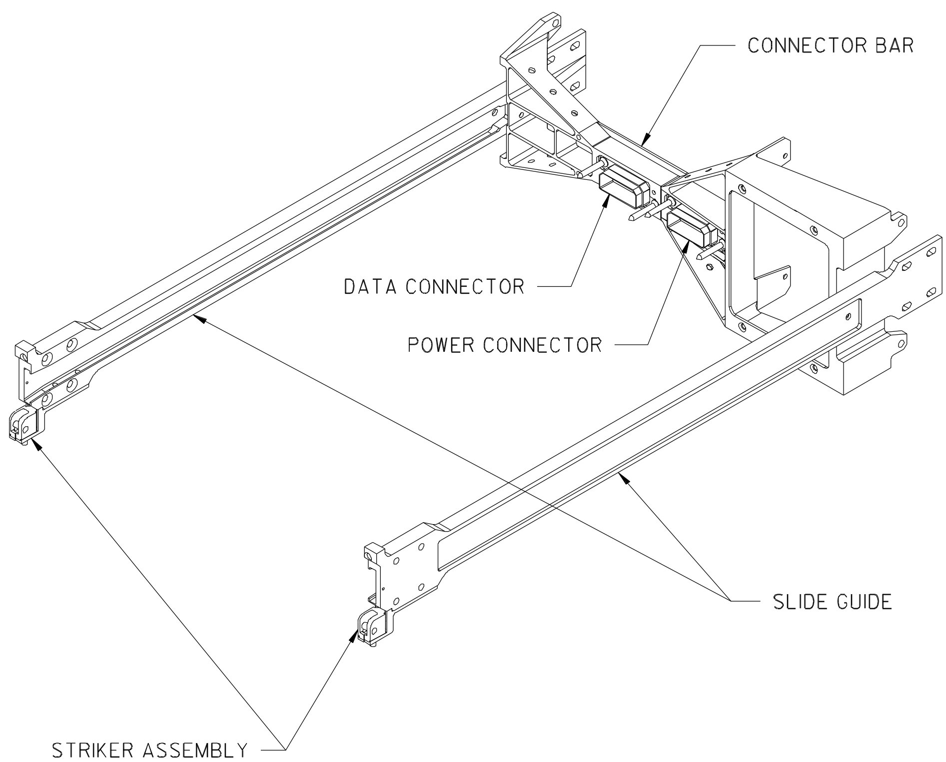


Figure 6.2.1.2-2. HRF Slide Guide Assembly

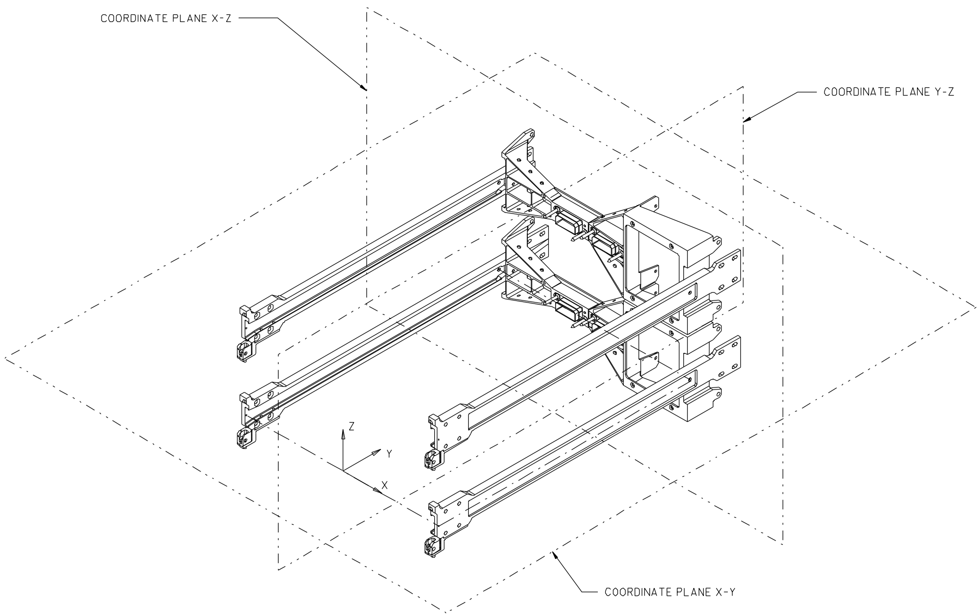


Figure 6.2.1.2-3. HRF Slide Guide Assembly Coordinate System

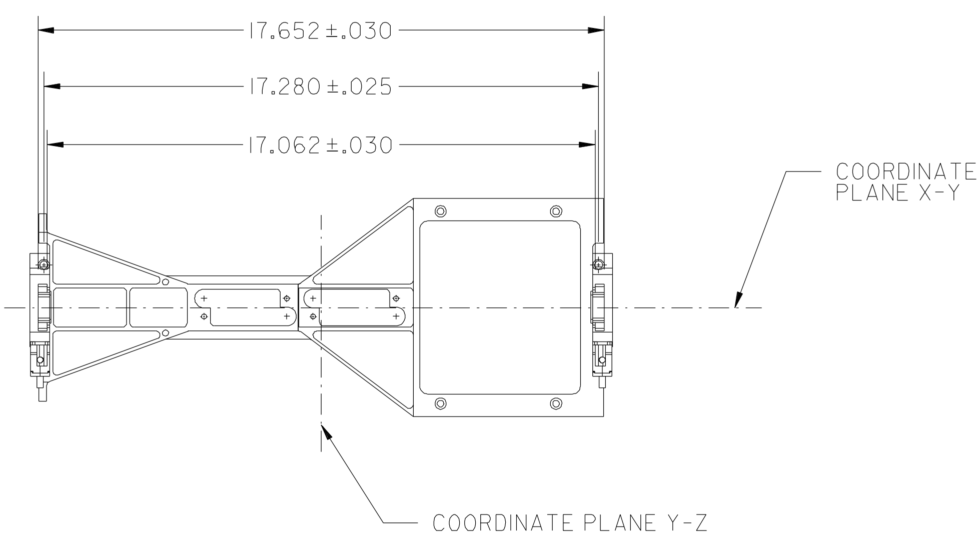


Figure 6.2.1.2-4. HRF Slide Guide Assembly Envelope

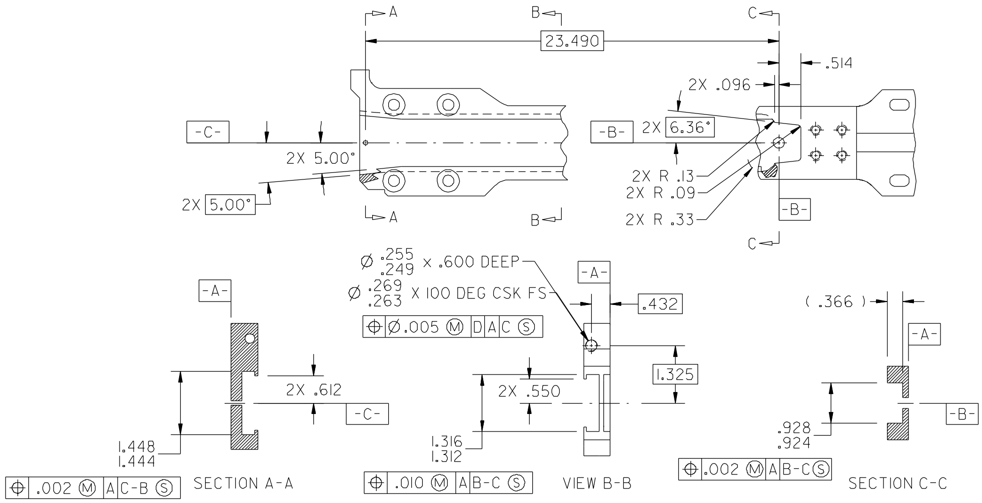


Figure 6.2.1.2-5. HRF Slide Guide/Wedge Socket Geometry

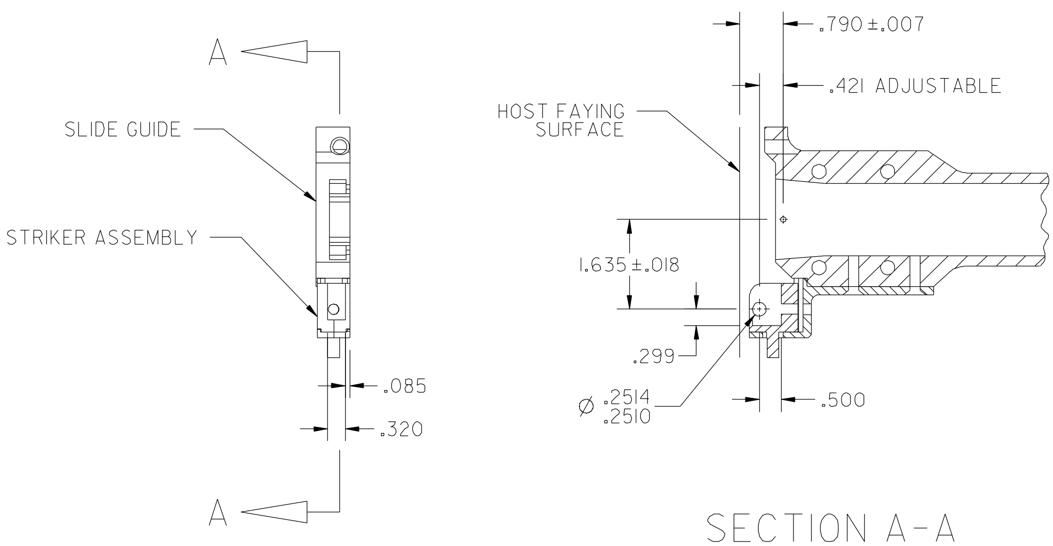


Figure 6.2.1.2-6. HRF Striker Assembly Geometry

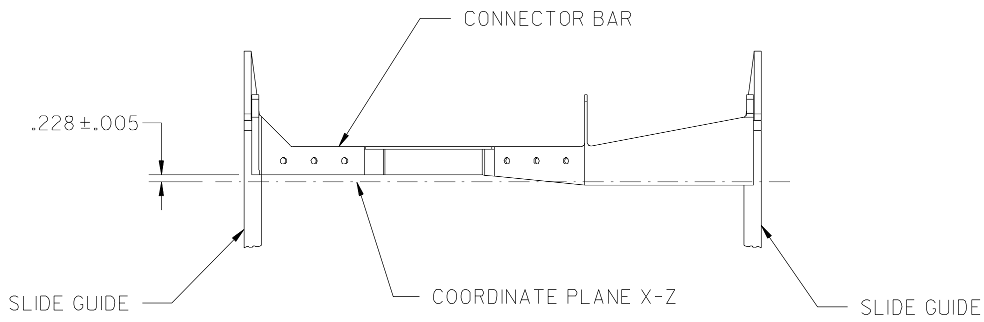
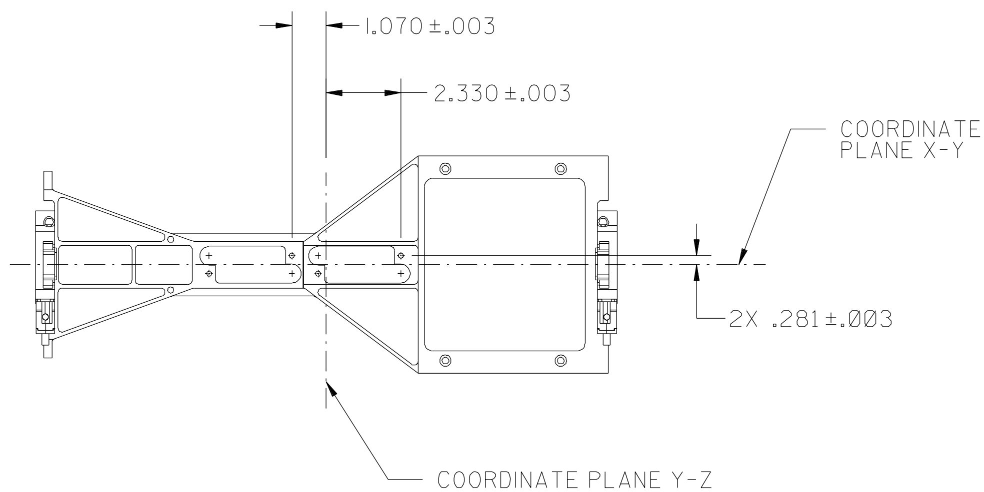


Figure 6.2.1.2-7. HRF Rack Connector Bar Location



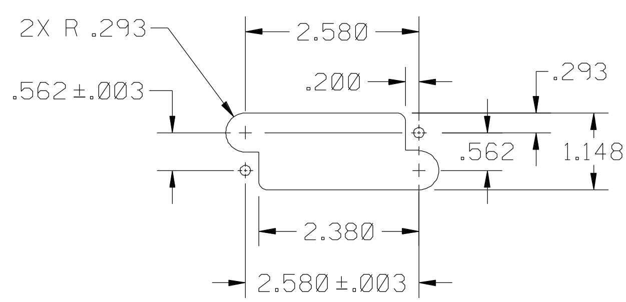


Figure 6.2.1.2-8. HRF Rack Connector Bar Connector Locations

6.2.1.2.3 HRF SIR Drawer Maximum Dimensional Envelopes

HRF rack mounted SIR drawer enclosures shall not exceed the maximum dimensions specified in Figures 6.2.1.2-9 through 6.2.1.2-12.

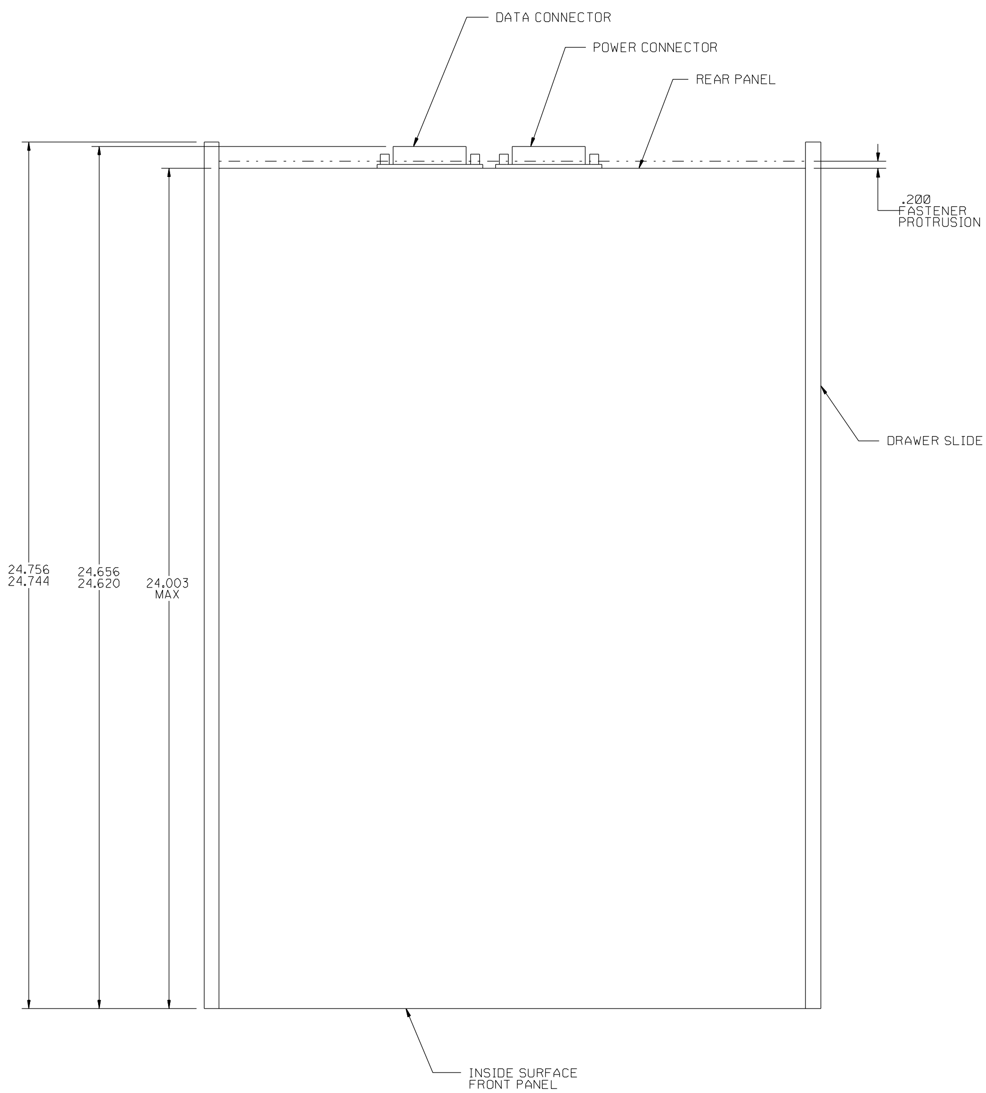


Figure 6.2.1.2-9. Maximum Drawer Envelope (Top View)

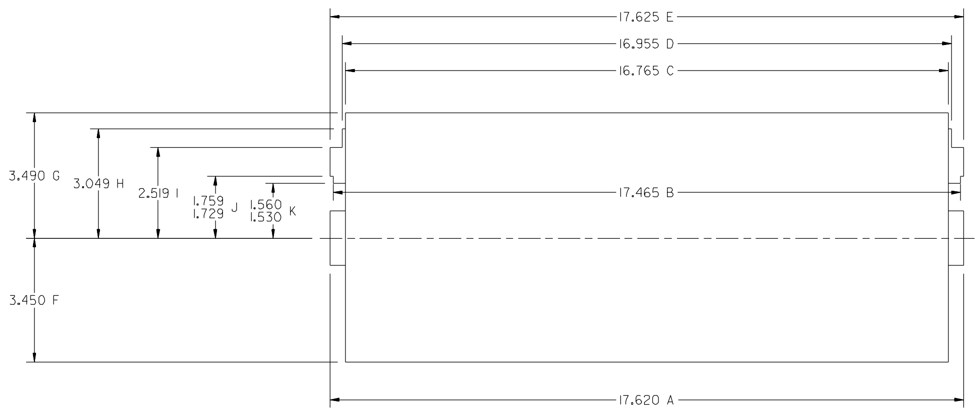


Figure 6.2.1.2-10. Maximum 4-PU Drawer Envelope (Front View)

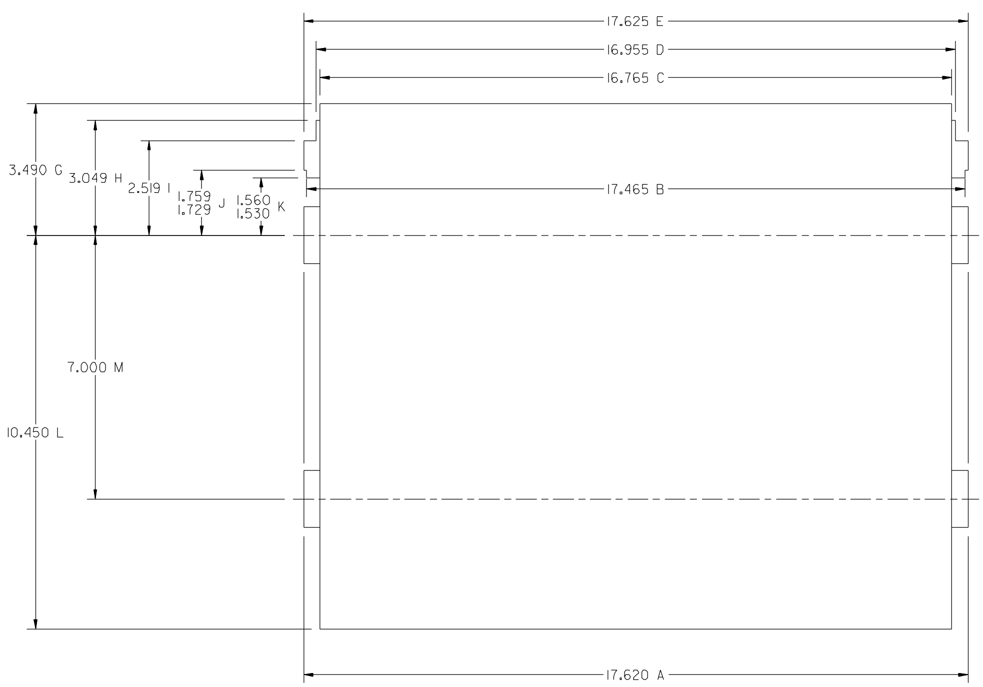


Figure 6.2.1.2-11. Maximum 8-PU Drawer Envelope (Front View)

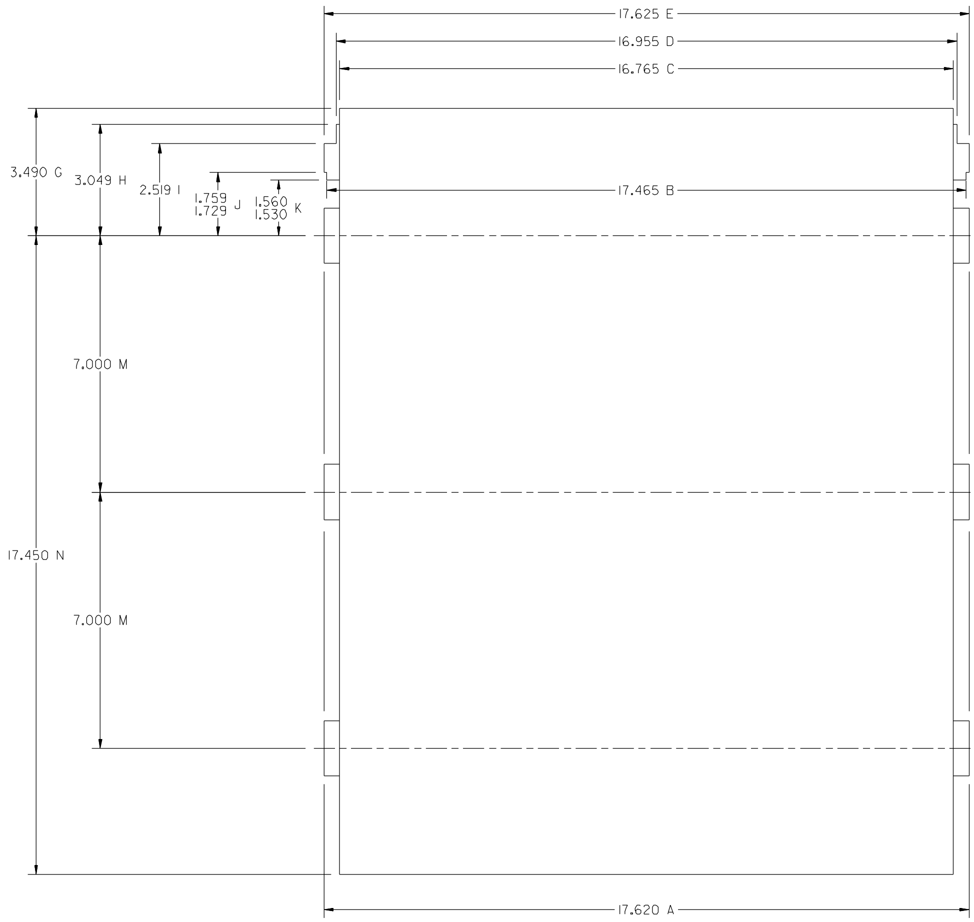


Figure 6.2.1.2-12. Maximum 12-PU Drawer Envelope (Front View)

6.2.1.2.4 HRF Rack Mounted Sir Drawer Center-of-Gravity Constraints

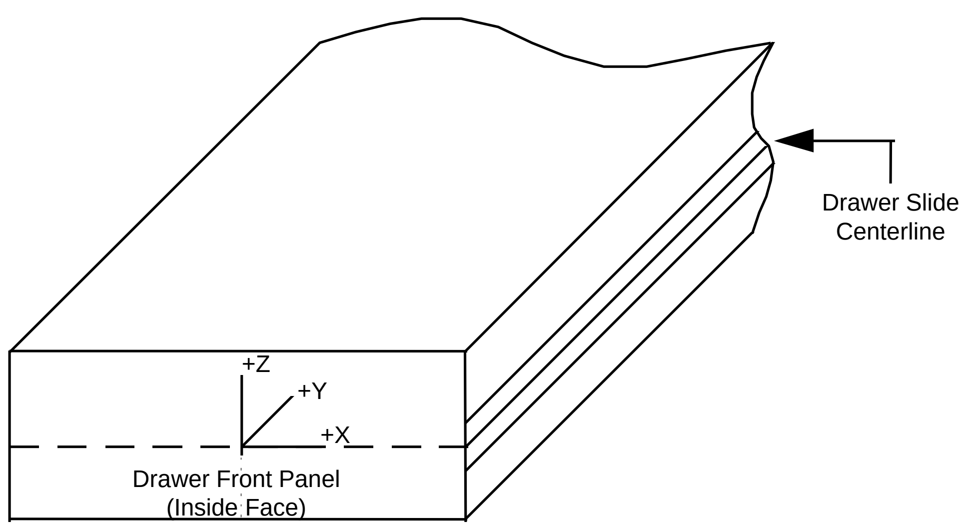
HRF rack mounted SIR drawer instruments shall meet the center of gravity constraints specified in Table 6.2.1.2-2, HRF SIR Drawer Center-of-Gravity Constraints.

TABLE 6.2.1.2-2. HRF SIR DRAWER CENTER-OF-GRAVITY CONSTRAINTS

Table I SIR Drawer Payload Center of Gravity Constraints

DRAWER CONFIGURATION	X (in) MIN.	X (in) MAX.	Y (in) MIN.	Y (in) MAX.	Z (in) MIN.	Z (in) MAX.
Single Slide Drawer (4 PU)	-1.75	+1.75	+7.99	+12.00	-0.63	+0.87
Double Slide Drawer (8PU)	-2.20	+2.20	+10.24	+14.00	+1.675	+3.975
Triple Slide Drawer (12PU)	-1.50	+1.50	+9.74	+13.00	+6.37	+8.87

NOTE: Center of gravity envelope is measured from the drawer coordinate system as defined below. The geometric center for "Z" axis is measured from the centerline of the bottom-most rail toward the top of the drawer. Total maximum integrated mass (including drawer, contents and slides) on any one set of slides is limited to 64 pounds. Multiple-slide drawers are to evenly distribute loading between the sets of slides.



6.2.1.2.5 HRF Rack Seat Track Interfaces

TBD

6.2.2 Electrical Power Requirements

Electrical requirements in this section are defined for instrument interfaces to the HRF rack 28 volt power outputs at HRF rack connector bars and rack connector panel. For the purposes of this section, compatibility means to remain safe and to provide operational functions within the range of accuracy specified for the instrument.

6.2.2.1 HRF Rack Power Output Connectors

6.2.2.1.1 SIR Drawer Power Connectors

SIR drawer instruments that receive electrical power from HRF rack connector bar interfaces shall connect to and be compatible with blind mate connector part number M83733/2RA018 with pin assignments as shown Figure 6.2.2.1-1 and Table 6.2.2.1-1.

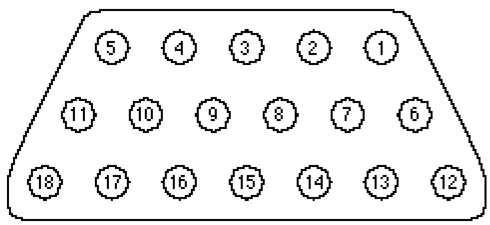


Figure 6.2.2.1-1. SIR Drawer Power Connector Part Number M83733/2RA018

TABLE 6.2.2.1-1. SIR DRAWER POWER CONNECTOR PIN ASSIGNMENTS

Pin	Type	Function	Note
1	Core	+28 vdc Supply	0 to 20 Amperes
2	Core	+28 vdc Return	
3		Not used	
4		Not used	
5		Not used	
6		Not used	
7		Not used	
8		Not used	
9		Not used	
10		Not used	
11		Not used	
12	Core	Chassis Ground	
13		Not used	
14		Not used	
15		Not used	
16		Not used	
17		Not used	
18		Not used	

6.2.2.1.2 Rack Connector Panel J1 Power Connector

Instruments that receive electrical power from the HRF rack connector panel J1 interface shall connect to and be compatible with the Series I jam nut receptacle part number MS27468T17F6SN with pin assignments as shown Figure 6.2.2.1-2 and Table 6.2.2.1-2.

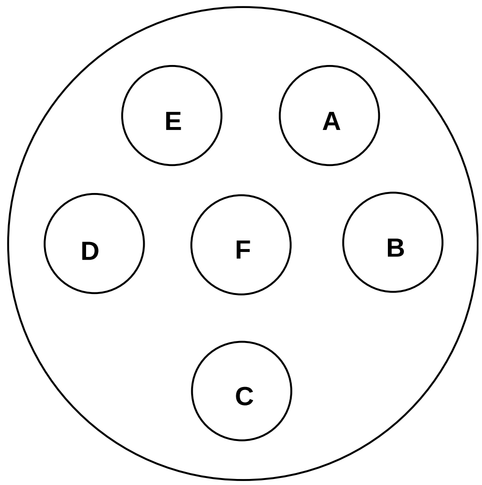


Figure 6.2.2.1-2. Rack Connector Panel J1 Power Connector Part Number MS27468T17F6SN

TABLE 6.2.2.1-2. RACK CONNECTOR PANEL J1 POWER CONNECTOR PIN ASSIGNMENTS

Pin	Type	Function	Note
A	Core	+28 vdc Supply	0 to 20 Amperes
B	Core	+28 vdc Return	
C	Core	Chassis Ground	
D		Not used	
E		Not used	
F		Not used	

6.2.2.2 Voltage Characteristics

6.2.2.2.1 Steady-State Operating Voltage Envelope

HRF rack dependent instruments shall be compatible with steady-state voltages within the range of +25.5 volts to + 29.5 volts.

6.2.2.2.2 Transient Operating Voltage Envelope

HRF rack dependent instruments shall be compatible with transient voltages within the range of +23.5 volts to + 30.5 volts for 60 ms.

6.2.2.2.3 Ripple Voltage/Noise Characteristics

A. HRF rack dependent instruments shall be compatible with a 1 volt peak to peak ripple in supply voltages within the ranges specified for steady-state and transient voltage envelopes.

B. HRF rack dependent instruments shall be compatible with the ripple voltage spectrum shown in Figure 6.2.2.2-1.

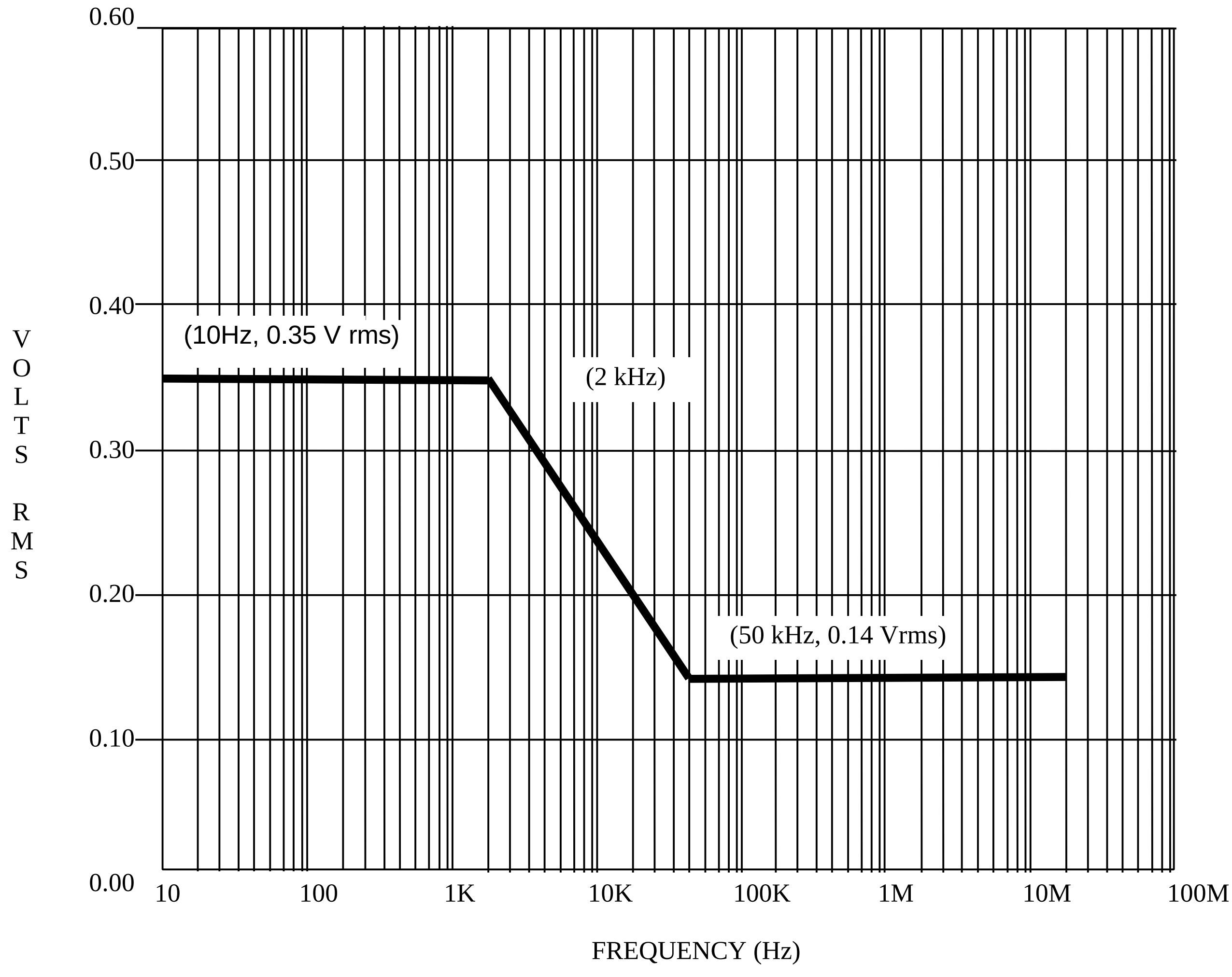
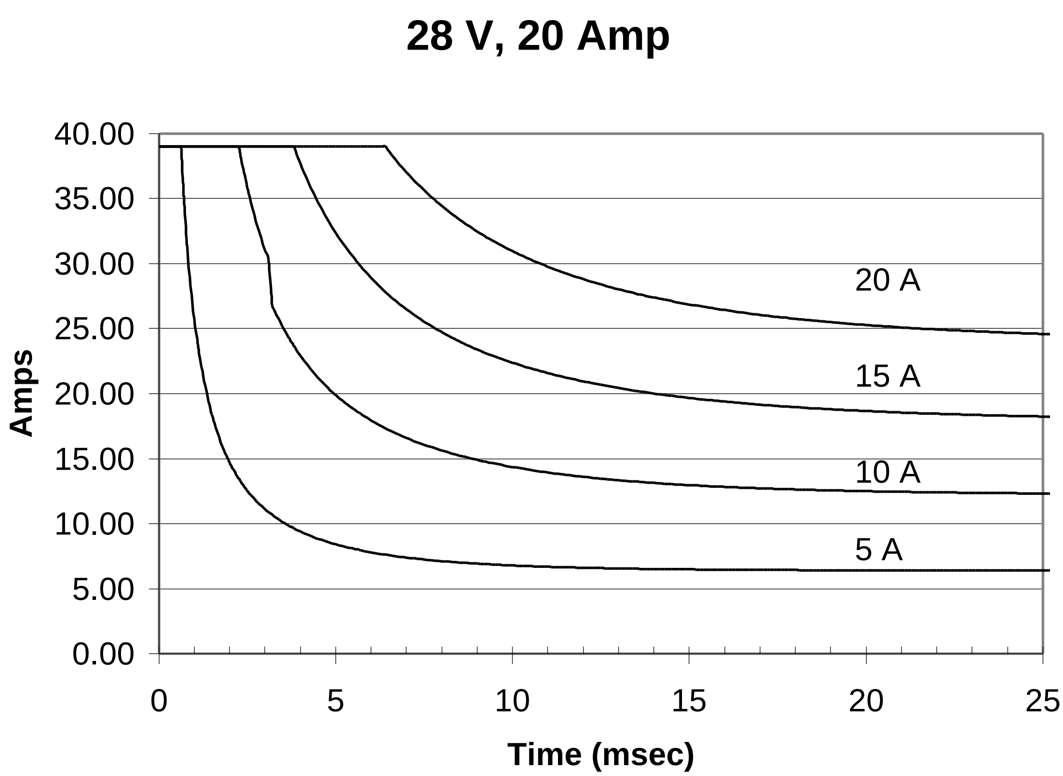


Figure 6.2.2.2–1. HRF Rack Power Output Ripple Voltage Spectrum

6.2.2.3 Maximum Current Limit

HRF rack dependent instruments shall be compatible with the maximum current provided for the selected current rating (5A, 10A, 15A, 20A) shown in Figure 6.2.2.3-1.



NOTES:

1) Current limit region shown above is defined for a capacitor load charge. In a direct short condition the actual trip time is 1/2 of the values shown.
2) For a progressive short in which the change in current has a slow rise time, an absolute maximum current limit of 2.5 times the normal current limit is provided. The time to trip for this condition is dictated by the I^2 x t trip limit.
3) Final current limit is obtained with in 100 µsecs. and the initial current limit is a maximum of 2 times the final.
4) The current limit is 39.0A +/-20%.
5) The trip values for the long-duration portion of the trip curves are a nominal 120% of range.

Figure 6.2.2.3-1. HRF Rack Power Output Trip Curves

6.2.2.4 Reverse Current

HRF rack dependent instrument reverse current shall not exceed the following values at each 28 V power interface:

(1) 600A pulse with a duration less than 10 μs.
(2) 450A peak with a duration less than 1 ms.
(3) 2A continuous.

6.2.2.5 Reverse Energy

HRF rack dependent instrument reverse energy shall not exceed 4 Joules at HRF rack 28 V power interfaces.

6.2.2.6 Capacitive Loads

HRF rack dependent instrument capacitive loads shall not exceed 50 microFarad per Ampere of rated output current at SIR drawer and rack connector panel power interfaces.

6.2.2.7 Electrical Power Consumer Constraints

6.2.2.7.1 Wire Derating

A. Circuit element derating criteria for instruments connected to HRF rack 28 volt power interfaces shall be per NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038. **[Modified from SSP 57000C, paragraph 3.2.3.1.B]**

B. Circuit element derating shall be based on the maximum trip current for a 20 A Solid State Power Controller (SSPC) as specified in Figure 6.2.2.3-1. **[Derived]**

6.2.2.7.2 Exclusive Power Feeds

Cabling shall not occur between Interface C connected EPCE with Interface B; and/or Interface B connected EPCE with Interface C. **[SSP 57000C, paragraph 3.2.3.2.B]**

6.2.2.7.3 Loss of Power

Payloads shall fail safe in the event of a total or partial loss of power regardless of the availability of Auxiliary power in accordance with NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.2.3.3]**

6.2.2.8 Electromagnetic Compatibility

HRF rack dependent instruments shall meet the payload provider applicable requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. **[SSP 57000C, paragraph 3.2.4]**

6.2.2.8.1 Electrical Grounding

HRF rack dependent instruments shall meet all requirements specified in section 3 of SSP 30240. **[SSP 57000C, paragraph 3.2.4.1]**

6.2.2.8.2 Electrical Bonding

Electrical bonding of HRF rack dependent instruments shall be in accordance with SSP 30245 and NSTS 1700.7B, ISS Addendum sections 213 and 220. **[SSP 57000C, paragraph 3.2.4.2]**

6.2.2.8.3 Cable/Wire Design and Control Requirements

HRF rack dependent instruments shall meet all cable and wire design requirements of SSP 30242. **[SSP 57000C, paragraph 3.2.4.3]**

6.2.2.8.4 Electromagnetic Interference

HRF rack dependent instruments shall meet all EMI requirements of SSP 30237. **[SSP 57000C, paragraph 3.2.4.4]**

Note: The alternative use of RS03 stated below applies to radiated susceptibility requirements only.

Alternately, the HRF rack dependent instruments may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown below, will hereafter be denoted RS03PL.

FREQUENCY	RS03PL LIMIT (V/m)
14 kHz – 400 MHz 5	5
400 MHz – 450 MHz	30
450 MHz – 1 GHz	5
1 GHz – 5 GHz	25
5 GHz – 6 GHz	60
6 GHz – 10 GHz	20
13.7 GHz – 15.2 GHz	25

COMMENTS: The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable. The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

6.2.2.9 Electrostatic Discharge

Unpowered HRF rack dependent instruments and components shall not be damaged by ESD equal to or less than 4,000 V to the case or any pin on external connectors. HRF rack dependent instruments that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. Labeling of HRF rack dependent instruments susceptible to ESD up to 15,000 V shall be in accordance with MIL–STD–1686. These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal. **[SSP 57000C, paragraph 3.2.4.5]**

6.2.2.10 Alternating Current (AC) Magnetic Fields

The generated AC magnetic fields, measured at a distance of 7 cm from the generating equipment, shall not exceed 140 dB above 1 picotesla for frequencies ranging from 30 Hz to 2 kHz, then falling 40 dB per decade to 50 kHz. **[SSP 57000C, paragraph 3.2.4.6]**

6.2.2.11 Direct Current (DC) Magnetic Fields

The generated DC magnetic fields shall not exceed 170 dB picotesla at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices. **[SSP 57000C, paragraph 3.2.4.7]**

6.2.2.12 Corona

HRF rack dependent instruments shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC–STD–531, High Voltage Design Criteria. **[SSP 57000C, paragraph 3.2.4.8]**

6.2.2.13 EMI Susceptibility for Safety-Critical Circuits

HRF rack dependent instrument safety-critical circuits, as defined in SSP 30243, shall meet the margins defined in SSP 30243, paragraph 3.2.3. **[SSP 57000C, paragraph 3.2.4.10]**

6.2.2.14 Safety Requirements

HRF rack dependent instruments shall meet the electrical safety requirements as defined in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.2.5.1.1]**

6.2.2.14.1 HRF Rack Dependent Instruments Electrical Safety

6.2.2.14.1.1 Mating/Demating of Powered Connectors

HRF rack dependent instruments shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-97-093. **[SSP 57000C, paragraph 3.2.5.1.1]**

6.2.2.14.1.2 Safety-Critical Circuits Redundancy

HRF rack dependent instruments shall meet the safety-critical circuits redundancy requirements defined in NSTS 18798, ET12-90-115. **[SSP 57000C, paragraph 3.2.5.1.2]**

6.2.2.15 Power Switches/Controls

A. Switches/controls performing on/off power functions for HRF rack dependent instruments shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position. **[SSP 57000C, paragraph 3.2.5.3.A]**

B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. **[SSP 57000C, paragraph 3.2.5.3.B]**

C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition. **[SSP 57000C, paragraph 3.2.5.3.C]**

6.2.2.16 Ground Fault Circuit Interrupters (GFCI)/Portable Equipment DC Sourcing Voltage

A. HRF rack dependent instruments power outlets with output voltages exceeding 30 volts rms or DC nominal (32 volts rms or DC maximum) intended to supply power to portable equipment shall include a GFCI, as an electrical hazard control, in the power path to the portable equipment. **[SSP 57000C, paragraph 3.2.5.4.A]**

B. GFCI trip current DC detection shall be independent of the portable equipment's safety (green) wire. **[SSP 57000C, paragraph 3.2.5.4.B]**

C. GFCI trip current AC detection shall be dependent on the portable equipment's safety (green) wire when the safety (green) wire is present. **[SSP 57000C, paragraph 3.2.5.4.C]**

D. HRF rack dependent instruments that generate internal voltages greater than 30 volts rms or DC nominal (32 volts rms or DC maximum) and has a credible fault path or return path to a crewmember shall include GFCI protection for that credible path with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table 6.2.2.12–1. **[SSP 57000C, paragraph 3.2.5.4.D]**

TABLE 6.2.2.12–1. LET-GO CURRENT PROFILE THRESHOLD VERSUS FREQUENCY

Frequency	Maximum Total Peak Current (AC + DC components combined) milliamperes
DC	40.0
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
10000	24.3
50000	24.3
(Based on 99.5 Percentile Rank of Adults)	

E. GFCI will be designed to trip below the threshold of let-go based upon the 99.5 percentile rank of adults. Non-portable utility outlets supplying power to portable equipment shall include a GFCI with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table 6.2.2.12–1. **[SSP 57000C, paragraph 3.2.5.4.E]**

F. GFCIs shall remove power within 25 milliseconds upon encountering the fault current. **[SSP 57000C, paragraph 3.2.5.4.F]**

G. GFCI shall provide an on-orbit method for testing trip current detection threshold at DC and at a frequency within the maximum human sensitivity range of 15 to 70 Hertz. **[SSP 57000C, paragraph 3.2.5.4.G]**

Note: The definitions of hazard requirements are specified in NSTS 1700.7B, ISS Addendum, paragraph 200.

6.2.2.17 Portable Equipment/Power Cords

A. Non-battery powered portable equipment shall incorporate a three-wire power cord; e.g., a 120 volt supply lead (+), a 120 volt return (–) lead and a safety (green) wire, one end connected to the portable equipment chassis (and all exposed conductive surfaces) and the other end connected to structure at the GFCI location through the GFCI interface. A system of double insulation or its equivalent, when approved by NASA, may be used without a ground wire. **[SSP 57000C, paragraph 3.2.5.5.A]**

B. Fault currents resulting from a single failure within a non-battery powered portable equipment shall not exceed the total peak currents specified in Table 3.2.5.4–1 for fault current frequencies of 15 Hertz and above. **[SSP 57000C, paragraph 3.2.5.5.B]**

6.2.3 Command and Data Handling Interface Requirements

6.2.3.1 HRF Rack Data Connectors

6.2.3.1.1 SIR Drawer Data Connectors

HRF rack dependent instruments requiring HRF rack data services at SIR drawer connector bar locations shall connect to blind mate connector part number M83733/2RA131, with pin assignments shown in Figure 6.2.3-1 and Table 6.2.3-1.

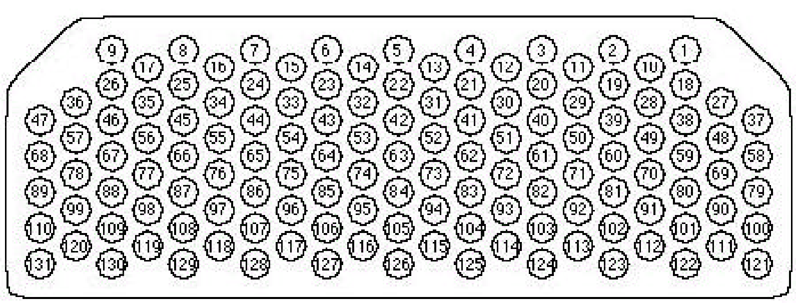


Figure 6.2.3-1. HRF SIR Drawer Data Connector Part Number M83733/2RA131

TABLE 6.2.3-1. HRF SIR DRAWER DATA CONNECTOR PIN ASSIGNMENTS

Pin	Interface	Function
1-3	Not used	
4	Discrete 1	High Bi-Directional
5	Discrete 2	High Bi-Directional
6-8	Not used	
9	Continuity	
10-12	Not used	
13	Discrete 1	Low Bi-Directional
14	Discrete 2	Low Bi-Directional
15-23	Not used	
24	Analog 1	High
25-32	Not used	
33	Discrete	Shield
34-43	Not used	
44	Analog 1	Low
45-46	Not used	
47	Video 1 from Drawer	High
48-50	Not used	
51	PPC Bus 01 (Daisy-chain)	High
52-56	Not used	
57	Video 1 from Drawer	Shield
58-60	Not used	
61	PPC Bus 01 (Daisy-chain)	Low
62	PPC Bus 02 (Daisy-chain)	Low
63-66	Not used	
67	TIA/EIA RS-422	Liner TX High
68	Video 1 from Drawer	Low
69-70	Not used	
71	PPC Bus 01 (Daisy-chain)	Shield
72	Not used	
73	PPC Bus 02 (Daisy chain)	Shield
74	Not used	
75	Analog	Shield
76	Not used	
77	TIA/EIA RS-422	Liner TX Shield
78	TIA/EIA RS-422	Liner RX High
79-82	Not used	
83	PPC Bus 02	High
84-87	Not used	
88	TIA/EIA RS-422	Liner TX Low
89	TIA/EIA RS-422	Liner RX Shield
90-91	Not used	
92	PPC Bus 03 (Transformer-coupled bus)	Shield
93	PPC Bus 03 (Transformer-coupled bus)	High
94-98	Not used	
99	TIA/EIA RS-422	Liner RX Low
100-102	Not used	
103	PPC Bus 03 (Transformer-coupled bus)	Low
104	Not used	
105	Ethernet	Liner Hub Receive +

Note: Pins 106-131 are not used.

6.2.3.1.2 HRF Rack Connector Panel J2 Data Connector

HRF rack dependent instruments requiring HRF rack data services at the rack connector panel J2 data connector location shall connect to a Series I connector part number MS27468T15F35S, with pin assignments shown in Figure 6.2.3-2 and Table 6.2.3-2.

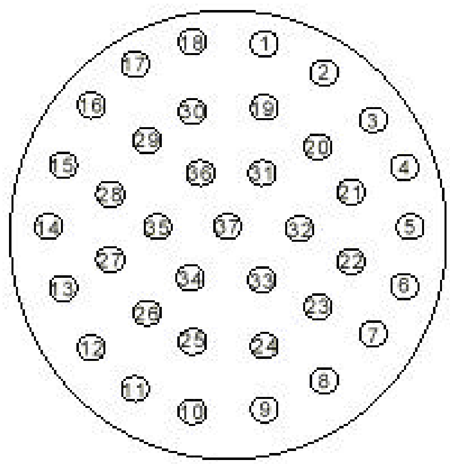


Figure 6.2.3-2. HRF Rack Connector Panel J2 Data Connector
Part Number MS27468T15F35S

TABLE 6.2.3-2. HRF RACK CONNECTOR PANEL J2 DATA CONNECTOR PIN ASSIGNMENTS

Pin	Type	Interface	Function	Note
1	Core	Video 1 to Liner	High	
2	Core	Video 1 to Liner	Low	
3		Not used		
4	Optional	Analog 1	High	Exp
5	Optional	Analog 1	Low	Exp
6-7		Not used		
8	Optional	Discrete 1	High Bi-Directional	Exp
9	Optional	Discrete 1	Low Bi-Directional	Exp
10	Optional	Discrete 2	High Bi-Directional	Exp
11	Optional	Discrete 2	Low Bi-Directional	Exp
12-13		Not used		
14	Core	Ethernet	Liner Hub Transmit +	
15	Core	Ethernet	Liner Hub Transmit -	
16	Core	Ethernet	Liner Hub Receive +	
17	Core	Ethernet	Liner Hub Receive -	
18-23		Not used		
24	Optional Reserved	PPC Bus 01 (Daisy-chain)	High	MSFC

TABLE 6.2.3-2. HRF RACK CONNECTOR PANEL J2 DATA CONNECTOR PIN ASSIGNMENTS (CONTINUED)

Pin	Type	Interface	Function	Note
25	Optional Reserved	PPC Bus 01 (Daisy-chain)	Low	MSFC
26	Optional Reserved	PPC Bus 02 (Daisy-chain)	High	MSFC
27	Optional Reserved	PPC Bus 02 (Daisy-chain)	Low	MSFC
28		Not used		
29	Optional Reserved	PPC Bus 03 (Transformer-coupled bus)	High	MSFC
30	Optional Reserved	PPC Bus 03 (Transformer-coupled bus)	Low	MSFC
31	Optional Reserved	PPC Bus 04 (Transformer-coupled bus)	High	MSFC
32	Optional Reserved	PPC Bus 04 (Transformer-coupled bus)	Low	MSFC
33		Not used		
34	Core	TIA/EIA RS-422	Liner RX High	
35	Core	TIA/EIA RS-422	Liner RX Low	
36	Core	TIA/EIA RS-422	Liner TX High	
37	Core	TIA/EIA RS-422	Liner TX Low	

6.2.3.2 HRF Ethernet Interfaces

Rack dependent instruments that require ethernet interfaces at the rack connector panel or at SIR drawer connector bars shall meet ANSI/IEEE 802.3 standards.

6.2.3.3 HRF TIA/EIA-422 Interfaces

Rack dependent instruments that require TIA/EIA-422 interfaces at the rack connector panel or at SIR drawer connector bars shall meet TIA/EIA-422 standards.

6.2.3.4 HRF Bi-Directional Discretes Interfaces

Rack dependent instruments that require bi-directional differential discrete interfaces at the rack connector panel or at SIR drawer connector bars shall be compatible with signal characteristics of 0vdc to 5vdc at a maximum current of 3.2 mA with a selectable sampling rate of 1 or 10 Hertz (Hz).

6.2.3.5 HRF Analog Interfaces

Rack dependent instruments that require differential analog interfaces at the rack connector panel or at SIR drawer connector bars shall be compatible with signal characteristics of -5vdc to +5vdc with a selectable sampling rate of 1, 10 or 100 Hz.

6.2.3.6 Word/Byte Notations, Types and Data Transmissions

This section applies to all payload commands and data on the LRDL, all header/trailer data on the MRDL and HRDL.

6.2.3.6.1 Word/Byte Notations

HRF rack dependent instruments shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. **[SSP 57000C, paragraph 3.3.2.1]**

6.2.3.6.2 Data Types

HRF rack dependent instruments shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. **[SSP 57000C, paragraph 3.3.2.2]**

6.2.3.7 HRF Software Requirements

A. File pathnames required for proper execution of the software shall be read from a configuration file rather than "hard coded" in the software. **[Derived]**

B. The rack dependent instrument software shall execute in the environment described in the host system IDD. (Workstation, Laptop, Common Software) **[Derived]**

C. The Rack dependent instruments software executable shall generate consistent results given the same initialization data. **[Derived]**

D. User interface software shall comply with the Display and Graphics Commonality Standards (DGCS) (http://139.169.159.8/idags/dgcs.html) and the International Space Station Operations United States Payload Operations Data File Payload Display Implementation Plan. **[Derived]**

E. Real-time data shall be formatted in accordance with the Life Sciences Data System (LSDS) Format. **[Derived]**

6.2.3.8 ISS C&DH Services Through HRF Common Software Interface

Rack dependent instruments obtaining HRF rack and Payload MDM services (e.g. ancillary data requests, file transfer, report health and status, etc.) through the HRF Common Software shall request services in accordance with LS-71062-8, Interface Definition Document for the Human Research Facility Common Software. **[Derived]**

6.2.3.9 ISS C&DH Services Through the HRF Rack Interface Controller (RIC)

Rack dependent instruments obtaining HRF rack and Payload MDM services (e.g. ancillary data requests, file transfer, report health and status, etc.) directly through the rack interface controller (RIC) (i.e., without HRF Common Software) shall request services through the HRF rack in accordance with D683-43631-1, EXPRESS Payload Software Interface Control Document - Human Research Facility. **[Derived]**

6.2.3.10 Medium Rate Data Link (MRDL)

The following requirements are defined for instruments connected to HRF rack Command and Data Handling (C&DH) interfaces that transfer data directly on the ISS MRDL (i.e., without using either RIC or HRF Common Software services).

6.2.3.10.1 Data Transmissions

HRF rack dependent instrument data transmission on MRDL shall use the data transmission order in accordance with paragraph 3.3.3.1, Transmission Order in SSP 52050. **[SSP 57000C, paragraph 3.3.2.3.B]**

6.2.3.10.2 CCSDS Data

A. HRF rack dependent instrument data that is space to ground shall be either CCSDS Data Packets or CCSDS Bitstream. **[SSP 57000C, paragraph 3.3.4.1.A]**

B. HRF rack dependent instrument data that is ground to space shall be CCSDS Data Packets. **[SSP 57000C, paragraph 3.3.4.1.B]**

C. HRF rack dependent instrument to Payload MDM data shall be CCSDS Data Packets. **[SSP 57000C, paragraph 3.3.4.1.C]**

6.2.3.10.2.1 CCSDS Data Packets

HRF rack dependent instrument data packets shall be developed in accordance with paragraph 3.1.3 of SSP 52050. Instrument CCSDS data packets consist of a primary header and a secondary header followed by the data field. **[SSP 57000C, paragraph 3.3.4.1.1]**

6.2.3.10.2.1.1 CCSDS Primary Header

HRF rack dependent instruments shall develop a CCSDS primary header in accordance with paragraph 3.1.3.1 CCSDS Primary Header Format of SSP 52050. **[SSP 57000C, paragraph 3.3.4.1.1.1]**

6.2.3.10.2.1.2 CCSDS Secondary Header

A. HRF rack dependent instruments shall develop a CCSDS secondary header immediately following the CCSDS primary header. **[SSP 57000C, paragraph 3.3.4.1.1.2.A]**

B. The CCSDS secondary header shall be developed in accordance with paragraph 3.1.3.2, CCSDS Secondary Header Format of SSP 52050. **[SSP 57000C, paragraph 3.3.4.1.1.2.B]**

6.2.3.10.2.2 CCSDS Data Field

HRF rack dependent instruments CCSDS data field shall contain the HRF rack dependent instrument data from the transmitting application to the receiving application, and the CCSDS checksum in accordance with paragraph 3.1 and subparagraphs, Data Formats and Standards, of SSP 52050. **[SSP 57000C, paragraph 3.3.4.1.2]**

6.2.3.10.2.3 CCSDS Application Process Identification Field

The CCSDS APID will be used for routing data packets as described in paragraph 3.3.2.1.3, APID Routing, of SSP 41175–2. The format of APIDs is shown in Table 3.3.2.1.1–1, CCSDS Primary Header Field Definitions, of SSP 41175–2. Telemetry APIDs for a payload or subrack payload will be assigned by the Payload Engineering and Integration function upon request from the payload or subrack payload developer or rack integrator, and will be recorded in the integrated rack unique software ICD. **[SSP 57000C, paragraph 3.3.4.1.4]**

6.2.4 Payload NTSC Video Interface Requirements

6.2.4.1 HRF Rack Video Connectors

6.2.4.1.1 SIR Drawer Video Interface

Rack dependent instruments that transmit video signals at SIR drawer connector bar locations shall interface with the connector specified in Figure 6.2.3-1 with pin assignment specified in Table 6.2.3-1.

6.2.4.1.2 Rack Connector Panel Interface

Rack dependent instruments that transmit video signals at the rack connector panel J2 location shall interface with the connector specified in Figure 6.2.3-2 with pin assignment specified in Table 6.2.3-2.

6.2.4.2 HRF Rack Video Interface Characteristics

Video transmissions from HRF rack dependent instruments to HRF rack video interfaces shall meet EIA RS-170 standards.

6.2.5 Thermal Control Interface Requirements

6.2.5.1 HRF Rack Provided ITCS Moderate Temperature Loop (MTL) Interface

HRF racks provide one MTL supply and one MTL return interface at the Rack Connector Panel.

6.2.5.1.1 HRF Rack MTL Interface Connectors

HRF rack dependent instruments that connect to the HRF rack MTL coolant water interface shall use quick disconnects in accordance with Figure 6.2.5.1-1.

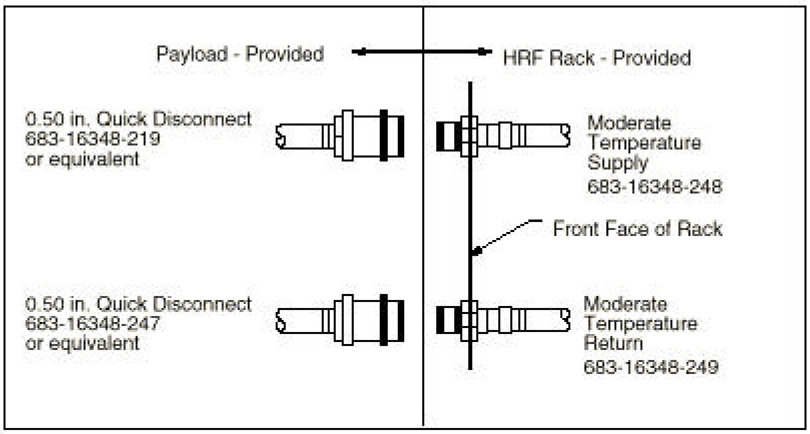


Figure 6.2.5.1-1. HRF Rack/Instrument Moderate Temperature Loop Interface

6.2.5.1.2 ITCS Fluid Use and Charging

A. ITCS Fluid Use

Coolant contained in the rack dependent instruments that interfaces with ITCS coolant shall satisfy the cleanliness and materials requirements specified in paragraph 6.2.11.3. **[SSP 57000C, paragraph 3.5.1.2.A]**

B. Rack Dependent Instrument Charging

Rack dependent instruments shall be delivered on-orbit charged with coolant as specified in paragraph 3.11.2 and during transport, rack dependent instruments that are not actively serviced by the MPLM Thermal Control System during transport shall be charged to allow for thermal expansion between the temperature of 1.67 °C (35 °F) and 46 °C (114.8 °F). **[SSP 57000C, paragraph 3.5.1.2.B]**

6.2.5.1.3 MTL Interface Maximum Heat Load

Maximum heat dissipation from HRF rack dependent instruments into the HRF rack MTL interface shall not exceed 500W.

6.2.5.1.4 Coolant Maximum Design Pressure

Rack dependent instruments shall withstand the MTL maximum design pressure of 121 psia (834 kPa). **[SSP 57000C, paragraph 3.5.1.7.A]**

6.2.5.1.5 Payload Coolant Quantity

Maximum allowable coolant quantity is defined by ISS at the integrated rack level only. Rack dependent instrument coolant quantity must be coordinated with HRF SE&I.

6.2.5.1.6 Fail Safe Design

Rack dependent instruments shall assess the instrument equipment internal water loop piping to ensure that it is fail safe in the case of loss of cooling under all modes of operation. **[SSP 57000C, paragraph 3.5.1.8]**

6.2.5.1.7 Leakage

Instrument coolant leakage is defined by ISS at the integrated rack level only. Instrument coolant leakage must be coordinated with HRF SE&I.

6.2.5.1.8 Quick-Disconnect Air Inclusion

Rack dependent instrument Quick Disconnects shall not exceed the maximum air inclusion of .30 cc maximum per mate or demate operation. **[SSP 57000C, paragraph 3.5.1.10]**

6.2.5.2 HRF Rack Heat Exchanger to SIR Drawer Interface

HRF racks provide one air to fluid heat exchanger at each 4 PU SIR drawer interface.

6.2.5.2.1 Heat Exchanger Interface Maximum Heat Load

HRF rack mounted SIR drawer instruments shall limit heat load into the heat exchanger to less than or equal to TBD Watts.

6.2.5.2.2 HRF Rack Mounted SIR Drawer Cooling Fans

A. Fan Hardware

SIR drawer instruments mounted in HRF racks shall use a HRF common fan, part number SEG46116060-701, defined in NASA/JSC drawing SEG 46116060. This drawing identifies the fan, mounting information, leadwire length, connector and pinout requirements. **[HRF Engineering Directive ED-003]**

B. Fan Location

The fan shall be located on the inside of the payload drawer in the rear right hand side (as viewed from the front of the rack). **[HRF Engineering Directive ED-003]**

C. Vibration Isolation

The fan shall be mounted with a Vibration Isolation Gasket between the fan and chassis. Reference NASA/JSC drawing SDG 46116118 for an example of an approved vibration absorbing gasket. **[HRF Engineering Directive ED-003]**

D. Fan Mounting

The fan mounting shall be such that the fan can be Intravehicular Activity (IVA) replaceable. This design is the responsibility of the hardware developer. Reference NASA/JSC drawing SEG 46116120 for an approved IVA replaceable fan design. **[HRF Engineering Directive ED-003]**

E. Fan Operating Voltage

Fans shall operate within a voltage range of 28 +0.5/-2.0 Vdc. **[HRF Engineering Directive ED-003]**

F. Fan Speed Controller

The hardware developer shall control the common fan at the lowest speed required to provide sufficient cooling air (32 °C inlet air temperature) to their instrument. This speed shall be determined by thermal analysis and HRF Systems Engineering and Integration. It is the hardware developer's responsibility for the design of a fan speed controller if one is deemed necessary. Reference NASA/JSC drawing SEG46115961 for an approved fan speed controller. **[HRF Engineering Directive ED-003]**

A fan-to-heat exchanger close-out gasket between the Payload Drawer and the Rack Connector bar will be provided by the rack integrator and installed onto the rack connector bar. **[HRF Engineering Directive ED-003]**

6.2.5.3 Front Panel Surface Temperature

Rack dependent instruments shall be designed such that the average front surface temperature is less than 37 °C (98.6 °F) with a maximum temperature limit not to exceed 45 °C (113 °F). **[SSP 57000C, paragraph 3.5.1.11]**

6.2.5.4 Cabin Air Heat Leak

Cabin air heat leak is defined by ISS at the module level only. Instrument cabin air heat leak must be coordinated with HRF SE&I.

6.2.5.5 Cabin Air Cooling

Cabin air cooling is defined by ISS at the integrated rack level only. Instrument cabin air cooling must be coordinated with HRF SE&I.

6.2.6 Vacuum System Requirements

6.2.6.1 HRF Rack Vacuum Interface Connectors

Rack dependent instruments that connect to HRF rack VES or Vacuum Resource System (VRS) interfaces shall use the connectors shown in Figure 6.2.6-1.

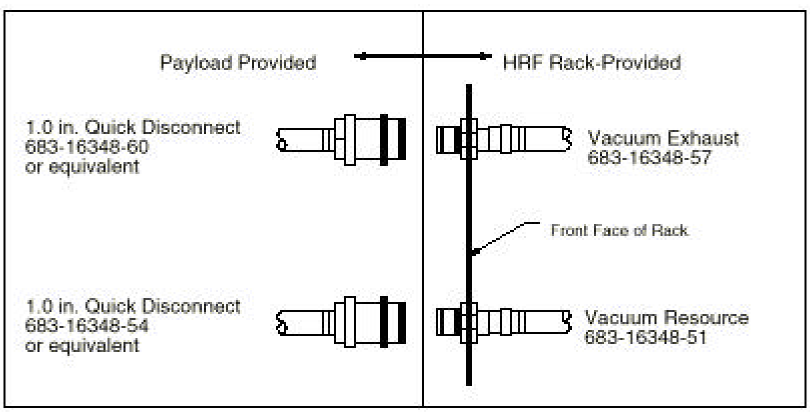


Figure 6.2.6-1. HRF Rack VES and VRS Interface Connectors

6.2.6.2 VES Requirements

6.2.6.2.1 Input Pressure Limit

A. Rack dependent instruments shall limit their vented exhaust gas to a pressure of 276 kPa (40 psia) or less at the rack to Station interface. **[SSP 57000C, paragraph 3.6.1.2.A]**

B. Rack dependent instrument volumes connected to the VES shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3. **[SSP 57000C, paragraph 3.6.1.2.B]**

6.2.6.2.2 Input Temperature Limit

The initial temperature range of exhaust gases shall be between 16 °C (60 °F) to 45 °C (113 °F). **[SSP 57000C, paragraph 3.6.1.3]**

6.2.6.2.3 Input Dewpoint Limit

The initial dewpoint of exhaust gases shall be limited to 16 °C (60 °F) or less. **[SSP 57000C, paragraph 3.6.1.4]**

6.2.6.2.4 Acceptable Exhaust Gases

A Rack dependent instrument exhaust gases vented into the vacuum exhaust system of the United States Laboratory (USL), APM, and JEM shall be compatible with the wetted surface materials of the respective laboratory(ies) in which the rack dependent instrument will operate, as defined in SSP 41002, paragraph 3.3.7.2. **[SSP 57000C, paragraph 3.6.1.5.A]**

B. Vented exhaust gases shall be limited to less than 25% (TBC) of the lower explosive limit for the gas mixture. **[SSP 57000C, paragraph 3.6.1.5.B]**

6.2.6.2.5 External Contamination Control

Exhaust gases shall be compatible with paragraph 3.4 of SSP 30426, Space Station External Contamination Control Requirements, for molecular column density, particulates, and deposition on external Space Station surfaces. **[SSP 57000C, paragraph 3.6.1.5.2]**

6.2.6.2.6 Incompatible Gases

A. Rack dependent instruments shall provide containment, storage, and transport hardware for gases that are incompatible with the vacuum exhaust or external environment. **[SSP 57000C, paragraph 3.6.1.5.3.A]**

B. Containment hardware for incompatible exhaust gases shall meet the redundant container requirements specified in NSTS 1700.7B, ISS Addendum, section 209.1b. **[SSP 57000C, paragraph 3.6.1.5.3.B]**

6.2.6.3 Vacuum Resource System Requirements

6.2.6.3.1 Input Pressure Limit

A. Rack dependent instruments shall limit their vented VRS gases to a pressure of 10^{-3} torr or less at the rack to Station interface. **[SSP 57000C, paragraph 3.6.2.2.A]**

B. Rack dependent instrument volumes connected to the VRS shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3. **[SSP 57000C, paragraph 3.6.2.2.B]**

6.2.6.3.2 VRS Through-Put Limit

Rack dependent instruments shall limit their gas throughput to the VRS to less than 1.2×10^{-3} torr liters/second. **[SSP 57000C, paragraph 3.6.2.3]**

6.2.6.3.3 Acceptable Gases

Note: Vacuum resource gases at 10^{-3} torr are not anticipated to damage the VRS.

6.2.7 Pressurized Gas Interface Requirements

6.2.7.1 Nitrogen Interface Requirements

6.2.7.1.1 HRF Rack Nitrogen Interface Connectors

Rack dependent instruments that connect to the HRF rack nitrogen interface shall use the connector shown in Figure 6.2.7-1.

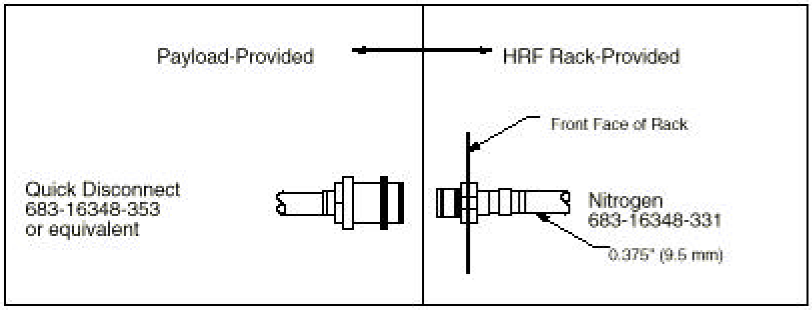


Figure 6.2.7-1. HRF Rack Nitrogen Interface Connectors

6.2.7.1.2 Nitrogen Interface Control

Rack dependent instruments shall provide a means, located within the instrument envelope, to turn on and off the flow of nitrogen from the integrated rack and to control the flow of nitrogen to not exceed 5.43 kg/hr (12 lbm/hr) when connected to the nitrogen interface operating pressure range of 517 to 827 kPa (75 to 120 psia). **[SSP 57000C, paragraph 3.7.1.1]**

6.2.7.1.3 Nitrogen Interface MDP

The MDP of the rack dependent instrument nitrogen system shall be 1,379 kPa (200 psia). **[SSP 57000C, paragraph 3.7.1.2]**

6.2.7.1.4 Nitrogen Interface Temperature

Rack dependent instrument nitrogen systems shall be designed for a nitrogen supply temperature range of 15.6 °C to 45 °C (60 °F to 113 °F). **[SSP 57000C, paragraph 3.7.1.3]**

6.2.7.1.5 Nitrogen Leakage

Nitrogen leakage is defined by ISS at the integrated rack level only. Instrument nitrogen leakage must be coordinated with HRF SE&I.

6.2.7.2 Pressurized Gas Bottles

The maximum allowable leak rate for pressurized gas bottles transported in the MPLM shall be 1670 SLPM. **[SSP 57000C, paragraph 3.7.5]**

6.2.7.3 Manual Valves

If a manual valve is employed for control of a pressurized gas, the valve shall be accessible as specified in paragraph 6.4.5.3 without rack rotation. **[SSP 57000C, paragraph 3.7.6]**

6.2.8 Payload Support Services Interfaces Requirements

6.2.8.1 Potable Water

6.2.8.1.1 ISS Potable Water Interface Connection

HRF rack dependent instruments that connect to the ISS portable water interface shall be compatible with a 683-16348, category 7, keying D fluid connector. **[SSP 57000C, paragraph 3.8.1.1, Table 3.1.1.6.1 item V]**

Instrument-provided containers used to convey water from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be compatible with the Orbiter water interfaces.

6.2.8.1.2 Potable Water Interface Pressure

The instrument-provided container, and all tubing, hoses and connectors used to connect to the ISS potable water interface shall not visibly leak when exposed to the ISS potable water interface pressure of 103.4 to 206.8 kPa gauge pressure (15 to 30 psig). **[SSP 57000C, paragraph 3.8.1.2]**

6.2.8.1.3 Potable Water Use

A. HRF rack dependent instrument use of water from the ISS water system that is not returned to the cabin air as humidity shall not exceed a daily average of 2.2 kg/day (4.8 lbm/day) based upon weekly usage. **[SSP 57000C, paragraph 3.8.1.3.A]**

B. The total use of water by the HRF rack dependent instruments from the ISS water system, including A and all water returned to the cabin air as humidity, shall be limited to not exceed a daily average of 5.51 kg/day (12.15 lbm/day) based upon weekly usage. **[SSP 57000C, paragraph 3.8.1.3.B]**

HRF rack dependent instruments water use from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be limited by fuel-cell water reserves available from the Orbiter after crew habitability needs have been addressed.

6.2.8.2 Fluid System Servicer

HRF rack dependent instruments that use the FSS shall meet the physical and functional interfaces depicted in Figure 1 of the FSS Interface Definition Drawing (IDD), 683-17103. **[SSP 57000C, paragraph 3.8.2]**

6.2.9 Environment Interface Requirements

6.2.9.1 Atmosphere Requirements

6.2.9.1.1 Pressure

Rack dependent instruments shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia). **[SSP 57000C, paragraph 3.9.1.1]**

6.2.9.1.2 Temperature

Rack dependent instruments shall be safe when exposed to temperatures of 10 to 46 °C (50 to 115 °F). **[SSP 57000C, paragraph 3.9.1.2]**

6.2.9.1.3 Humidity

Rack dependent instruments shall be designed to not cause condensation when exposed to a dewpoint of 4.5 to 15.6 °C (40 to 60 °F) and a relative humidity of 25 to 75% except when condensation is an intended operation of the instrument. **[SSP 57000C, paragraph 3.9.1.3]**

6.2.9.2 Instrument Use of Cabin Atmosphere

6.2.9.2.1 Active Air Exchange

Active air exchange with the cabin atmosphere by rack and sub-rack payloads shall be limited to air exchange for specimen metabolic purposes and for mass conservation purposes. **[SSP 57000C, paragraph 3.9.2.1.A]**

6.2.9.2.2 Oxygen Consumption

Consumption of atmospheric oxygen by equipment or experiment processes is defined by ISS at the integrated rack level only. Consumption of atmospheric oxygen by rack dependent instruments must be coordinated with HRF SE&I.

6.2.9.2.3 Chemical Releases

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.9.2.3]**

6.2.9.3 Ionizing Radiation Requirements

6.2.9.3.1 Instrument Contained or Generated Ionizing Radiation

Rack dependent instruments containing or using radioactive materials or that generate ionizing radiation shall comply with NSTS 1700.7B, ISS Addendum, paragraph 212.1. **[SSP 57000C, paragraph 3.9.3.1]**

6.2.9.3.2 Ionizing Radiation Dose

Instruments should expect a total dose (including trapped protons and electrons) of 30 Rads(Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC–TN–9550) may show ionizing radiation exposure to be different than 30 Rads (Si) per year, if the intended location of the rack in the ISS is known.

6.2.9.3.3 Single Event Effect (SEE) Ionizing Radiation

Instruments shall be designed not to produce an unsafe condition or one that could cause damage to equipment as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils). **[SSP 57000C, paragraph 3.9.3.3]**

6.2.9.3.4 Additional Environmental Conditions

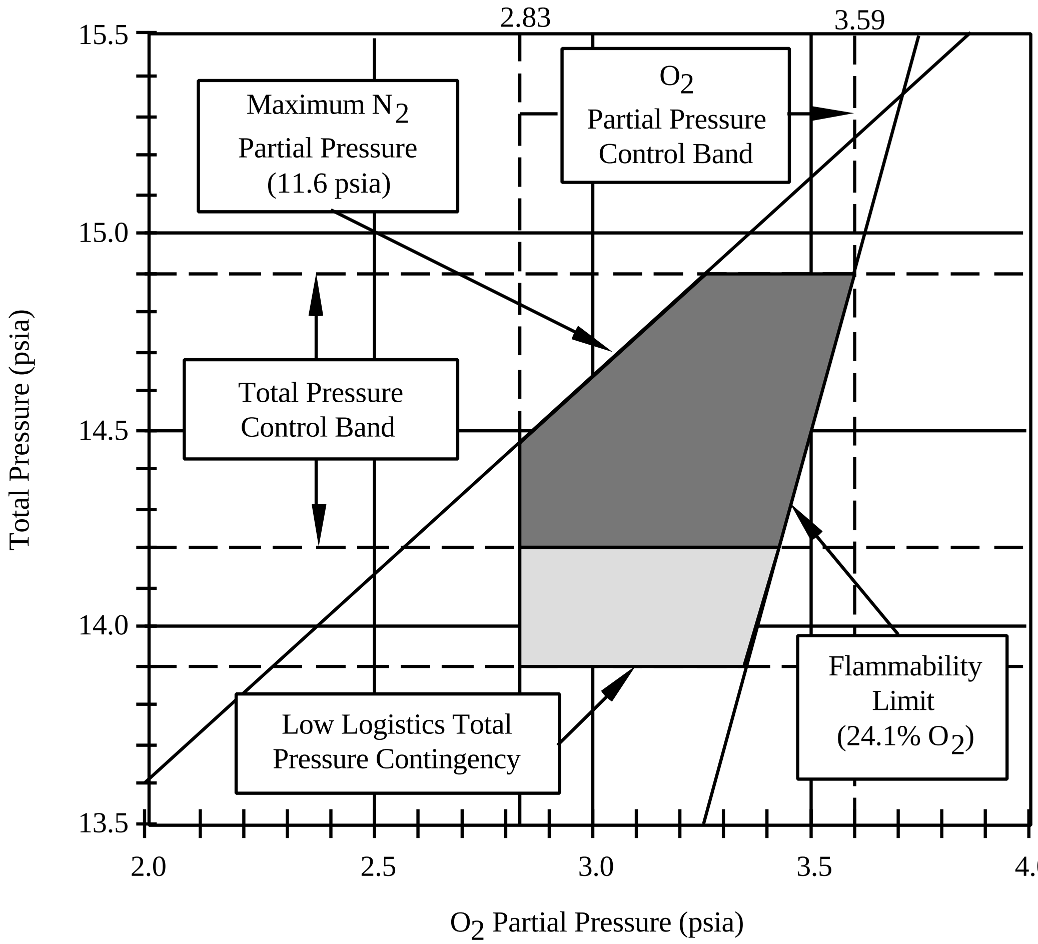
The environmental information provided in Table 6.2.9.3–1, Environmental Conditions on ISS, is for design and analysis purposes.

TABLE 6.2.9.3–1. ENVIRONMENTAL CONDITIONS ON ISS

Environmental Condition	Value
Atmospheric Conditions	
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)
Normal operating pressure	See Figure 3.9.3.4-1
Oxygen partial pressure	See Figure 3.9.3.4-1
Nitrogen partial pressure	See Figure 3.9.3.4-1
Dewpoint	4.4 to 15.6 °C (40 to 60 °F)
Percent relative humidity	25 to 75
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mm Hg Peak exposure 10 mm Hg
Cabin air temperature in USL, JEM, APM, and CAM	17 to 28 °C (63 to 82 °F)
Cabin air temperature in Node 1	17 to 31 °C (63 to 82 °F)
Air velocity	0.051 to 2.03 m/s (10 to 40 ft/min)
Airborne microbes	Less than 1000 CFU/m^3
Atmosphere particulate level	Average less than 1000,000 particles/ft^3 for particles less than 0.5 microns in size
MPLM Air Temperatures	**Active Flights**
Pre-Launch	14 to 30 °C (57.2 to 86 °F)
Launch/Ascent	20 to 30 °C (68 to 86 °F)
On-orbit (Cargo Bay + Deployment)	16 to 46 °C (60.8 to 114.8 °F)
On-orbit (On-Station)	16 to 43 °C (63 to 109.4 °F)
On-orbit (Retrieval + Cargo Bay)	11 to 45 °C (63 to 113 °F)
Descent/Landing	10 to 42 °C (50 to 107.6 °F)
Post-Landing	10 to 42 °C (50 to 107.6 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
	Passive Flights
Pre-Launch	15 to 24 °C (59 to 75.2 °F)
Launch/Ascent	14 to 24 °C (57.2 to 75.2 °F)
On-orbit (Cargo Bay + Deployment)	24 to 44 °C (75.2 to 111.2 °F)
On-orbit (On-Station)	23 to 45 °C (73.4 to 113 °F)
On-orbit (Retrieval + Cargo Bay)	17 to 44 °C (62.6 to 111.2 °F)
Descent/Landing	13 to 43 °C (55.4 to 109.4 °F)
Post-Landing	13 to 43 °C (55.4 to 109.4 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
Thermal Conditions	
USL module wall temperature	13 °C to 43 °C (55 °F to 109 °F)
JEM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
APM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
CAM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
Other integrated payload racks	Front surface less than 37 °C (97 °F)
***Microgravity**	
Quasi-Steady State Environment	See Figures 3.9.3.4-2, 3.9.3.4-3 and Table 3.9.3.4-2
Vibro-acoustic Environment	See Figure 3.9.3.4-4
General Illumination	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle

*Note: Data reflects best available information as of May, 1997. Does not include effects of CAM.

[SSP 57000C, TABLE 3.9.3.4–1]



[SSP 57000C, FIGURE 3.9.3.4–1]

Figure 6.2.9.3–1. Operating Limits of the ISS Atmospheric Total Pressure, and Nitrogen and Oxygen Partial Pressures

6.2.10 Fire Protection Interface Requirements

HRF dependent instruments that have forced air circulation and are mounted in SIR drawer locations within the HRF rack are monitored by the HRF rack smoke detector. The ISS PFE is capable of extinguishing fires within these instrument volumes when discharged into the HRF rack PFE access port. These instruments do not require additional smoke detectors or PFE access ports.

Fire detection requirements for instruments operated outside of the rack have not been defined by ISS. Fire detection methodology for instruments operated outside of rack volumes must be approved by the PSRP. Fire suppression requirements in this section apply for instruments operated outside of the rack volume that have forced air flow.

6.2.10.1 Fire Prevention

HRF rack dependent instruments shall meet the fire prevention requirements specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10a. **[SSP 57000C, paragraph 3.10.1]**

6.2.10.2 Portable Fire Extinguisher

A. HRF rack dependent instruments with forced air flow mounted outside of the rack volume that have a panel thickness less than or equal to 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 6.2.1.1–1. **[SSP 57000C, paragraph 3.10.3.1.A]**

B. HRF rack dependent instruments with forced air flow mounted outside of the rack volume that have a panel thickness greater than 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 6.2.1.1–1. **[SSP 57000C, paragraph 3.10.3.1.B]**

Note 1: The final determination of whether or not a payload volume contains a potential fire source and requires a PFE access port will be presented to and approved by the PSRP during the phased safety reviews.

Note 2: The ISS PFE has an “open cabin” diffuser nozzle which will be used to surround fire events that are not in an enclosed volume with suppressant.

Note 3: Internal volumes are volumes presented to and approved by the PSRP as sealed containers do not require PFE access ports.

6.2.10.3 Fire Suppression Access Port Accessibility

Rack dependent instruments requiring an access port shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figure 6.4.4.1.1–1 so the PFE nozzle can interface to the PFE port. **[SSP 57000C, paragraph 3.10.3.2]**

6.2.10.4 Fire Suppressant Distribution

The internal layout of HRF rack dependent instruments shall allow ISS PFE fire suppressant to be distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. **[SSP 57000C, paragraph 3.10.3.2]**

Note: The position of HRF rack dependent instruments internal components near the PFE Access Port should not prevent fire suppressant to be discharged into the volume the PFE Access Port serves. PFE discharge characteristics are specified in Figure 6.2.1.1–1 and PFE closed volume nozzle dimensions are specified in Figure 6.4.4.1.1–2.

6.2.11 Materials and Parts Interface Requirements

6.2.11.1 Materials and Parts Use and Selection

HRF rack dependent instruments shall use materials and parts that meet the materials requirements specified in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.11.1]**

6.2.11.2 Commercial Parts

COTS parts used in HRF rack dependent instruments shall meet the materials requirements specified in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.11.1.1]**

6.2.11.3 Fluids

A. HRF rack dependent instruments which connect to ISS fluid systems shall use fluids that meet the requirements specified in SSP 30573. **[SSP 57000C, paragraph 3.11.2.A]**

B. HRF rack dependent instruments which connect to ISS fluid systems shall meet the fluid system cleanliness levels specified in SSP 30573. **[SSP 57000C, paragraph 3.11.2.B]**

C. HRF rack dependent instruments using ISS aqueous fluid systems shall use internal materials that are compatible according to MSFC–SPEC–250, Table III or that will not create a potential greater than 0.25 Volts with the ISS system internal materials due to a dissimilar metal couple. **[SSP 57000C, paragraph 3.11.2.C]**

6.2.11.4 Cleanliness

HRF rack dependent instruments shall conform to Visibly Clean-Sensitive (VC–S) cleanliness requirements as specified in SN–C–0005. **[SSP 57000C, paragraph 3.11.3]**

6.2.11.5 Fungus Resistant Material

HRF rack dependent instruments that are intended to remain on-orbit for more than one year shall use fungus resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10. **[SSP 57000C, paragraph 3.11.4]**

6.3 ISS DESIGN REQUIREMENTS FOR HRF RACK INDEPENDENT INSTRUMENTS

This section contains SSP 57000 design requirements generically applicable to HRF rack independent instruments. Interface requirements for rack independent instruments are dependent on the host system interfaces to which the instrument will connect and are not contained in this section. The HRF SE&I group will coordinate host system specific interface requirements with instrument developers on an individual basis and document these requirements in instrument unique SRDs and ICDs. For the purpose of this document, rack independent instruments are defined as those instruments that do not specifically require HRF rack interfaces during primary operations. Instruments with data storage capabilities that require temporary connections to HRF rack power and data interfaces for data transfer before or after primary operations and do not require the HRF rack to be powered at specific intervals are considered to be HRF rack independent.

Note: For configuration management purposes, requirement text defined in SSP 57000 is documented here verbatim, with the two exceptions. The terms “integrated rack” or “rack” have been replaced with “rack independent instruments” for ISS design requirements generically applicable to rack independent instruments. Paragraph, figure and table numbers specified in SSP 57000 requirement text that are contained in this document have been changed to conform to the numbering structure of this document. No corrections to spelling, punctuation, first occurrence or use of acronyms have been made.

6.3.1 Structural/Mechanical

6.3.1.1 Safety Critical Structures Requirements

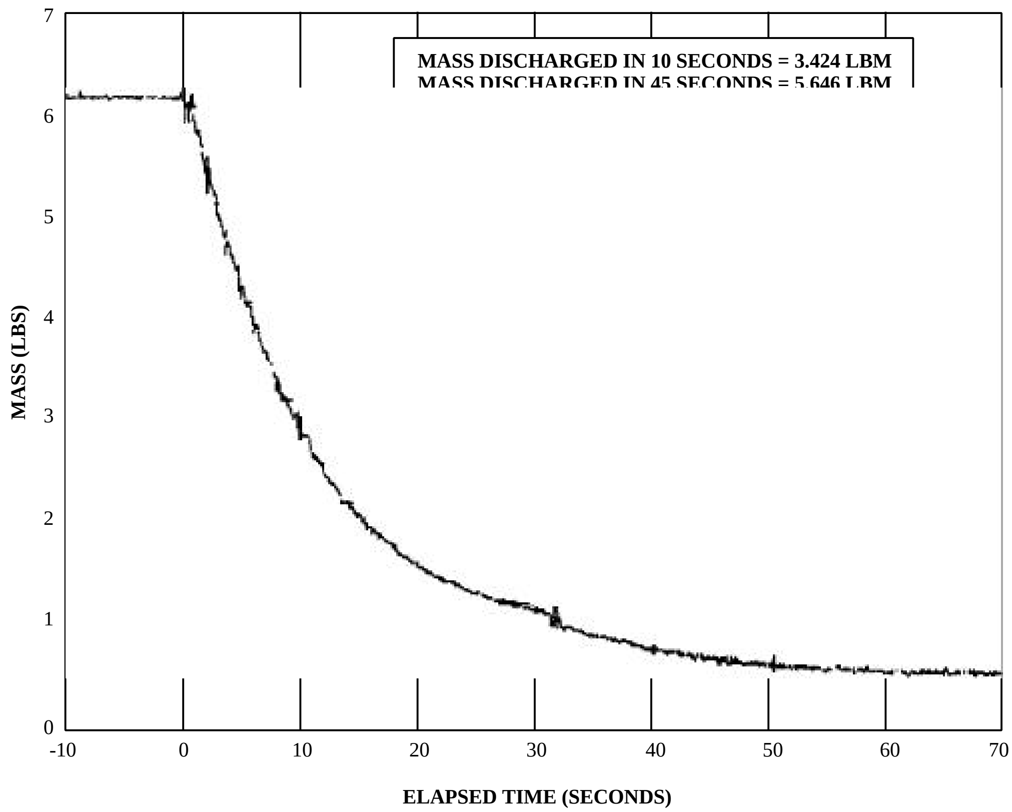
Rack independent instruments shall be designed in accordance with the requirements specified in SSP 52005. **[SSP 57000C, paragraph 3.1.1.5.A]**

6.3.1.2 Dynamic Pressure Requirements

A. Rack independent instruments shall maintain positive margins of safety for maximum depressurization and repressurization rates for the carrier(s) in which it will be transported.

B. Rack independent instruments shall maintain positive margins of safety for the on-orbit depress/repress rates identified in SSP 41002 paragraph 3.1.7.2.1. **[SSP 57000C, paragraph 3.1.1.4.B]**

C. Rack independent instruments that have PFE access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 6.3.1.1–1. **[SSP 57000C, paragraph 3.1.1.4.K]**



[SSP 57000C, FIGURE 3.1.1.4–1]

Figure 6.3.1.1–1. Manual Fire Suppression System Performance Characteristics

6.3.1.3 Loads Requirements

A. Rack independent instruments shall provide positive margins of safety for launch and landing loading conditions in for the carrier(s) in which it will be transported.

B. Rack independent instruments shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction. **[SSP 57000C, paragraph 3.1.1.3.B]**

C. Rack independent instruments shall provide positive margins of safety when exposed to the crew-induced loads defined in Table 6.3.1.3–1, Crew-Induced Loads. **[SSP 57000C, paragraph 3.1.1.3.D]**

TABLE 6.3.1.3–1. CREW-INDUCED LOADS

CREW SYSTEM OR STRUCTURE	TYPE OF LOAD	LOAD	DIRECTION OF LOAD
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N-M (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf), limit	Any direction
Cabinets and any normally exposed equipment	Concentrated load applied by flat round surface with an area of (0.093 m^2) (1 ft^2)	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

[SSP 57000C, TABLE 3.1.1.3-1]

6.3.1.4 Microgravity

Microgravity requirements have not been defined by the ISS Program

6.3.1.4.1 Quasi-Steady Requirements

TBD

6.3.1.4.2 Vibratory Requirements

TBD

6.3.1.4.3 Transient Requirements

TBD

6.3.2 <u>Electrical Design Requirements</u>

6.3.2.1 Wire Derating

A. Wire derating for wire/cable between rack independent instruments and the UOP shall be in accordance with SSP 30312. **[SSP 57000C, paragraph 3.2.3.1.A]**

B. Derating criteria for rack independent instrument circuit elements below the first level of instrument provided circuit protection shall be per NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038. **[SSP 57000, paragraph 3.2.3.1.B]**

6.3.2.2 Exclusive Power Feeds

Cabling shall not occur between Interface C connected EPCE with Interface B; and/or Interface B with Interface C. **[SSP 57000C, paragraph 3.2.3.2.B]**

6.3.2.3 Loss of Power

Rack independent instruments shall fail safe in the event of a total or partial loss of power regardless of the availability of Auxiliary power in accordance with NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.2.3.3]**

6.3.2.4 Electromagnetic Compatibility

Rack independent instruments shall meet the payload provider applicable requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. **[SSP 57000C, paragraph 3.2.4]**

6.3.2.4.1 Electrical Grounding

Rack independent instruments shall meet all requirements specified in section 3 of SSP 30240. **[SSP 57000C, paragraph 3.2.4.1]**

6.3.2.4.2 Electrical Bonding

Electrical bonding of rack independent instruments shall be in accordance with SSP 30245 and NSTS 1700.7B, ISS Addendum sections 213 and 220. **[SSP 57000C, paragraph 3.2.4.2]**

6.3.2.4.3 Cable/Wire Design and Control Requirements

Rack independent instruments shall meet all Cable and Wire Design requirements of SSP 30242. **[SSP 57000C, paragraph 3.2.4.3]**

6.3.2.4.4 Electromagnetic Interference

Rack independent instruments shall meet all EMI requirements of SSP 30237. **[SSP 57000C, paragraph 3.2.4.4]**

Note: The alternative use of RS03 stated below applies to radiated susceptibility requirements only.

Alternately, the payload EPCE may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown below, will hereafter be denoted RS03PL.

FREQUENCY	RS03PL LIMIT (V/m)
14 kHz – 400 MHz 5	5
400 MHz – 450 MHz	30
450 MHz – 1 GHz	5
1 GHz – 5 GHz	25
5 GHz – 6 GHz	60
6 GHz – 10 GHz	20
13.7 GHz – 15.2 GHz	25

COMMENTS: The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable. The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

6.3.2.5 Electrostatic Discharge

Unpowered rack independent instruments shall not be damaged by ESD equal to or less than 4,000 V to the case or any pin on external connectors. EPCE that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. Labeling of EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL–STD–1686. These voltages are the result of charges that may be accumulated and discharged from ground personnel or crew members during equipment installation or removal. **[SSP 57000C, paragraph 3.2.4.5]**

6.3.2.6 Alternating Current (AC) Magnetic Fields

The generated ac magnetic fields, measured at a distance of 7 cm from the generating equipment, shall not exceed 140 dB above 1 picotesla for frequencies ranging from 30 Hz to 2 kHz, then falling 40 dB per decade to 50 kHz. **[SSP 57000C, paragraph 3.2.4.6]**

6.3.2.7 Direct Current (DC) Magnetic Fields

The generated DC magnetic fields shall not exceed 170 dB picotesla at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices. **[SSP 57000C, paragraph 3.2.4.7]**

6.3.2.8 Corona

Rack independent instruments shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC–STD–531, High Voltage Design Criteria. **[SSP 57000C, paragraph 3.2.4.8]**

6.3.2.9 EMI Susceptibility for Safety-Critical Circuits

Rack independent instruments safety-critical circuits, as defined in SSP 30243, shall meet the margins defined in SSP 30243, paragraph 3.2.3. **[SSP 57000C, paragraph 3.2.4.10]**

6.3.2.10 Instrument Electrical Safety

Rack independent instruments shall meet the electrical safety requirements as defined in NSTS 1700.7 Addendum.

6.3.2.10.1 Mating/Demating of Powered Connectors

Rack independent instruments shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-97-093. **[SSP 57000C, paragraph 3.2.5.1.1]**

Note: The module can provide one verifiable upstream inhibit which removes voltage from the UIP and UOP connectors. The module design will provide the verification of the inhibit status at the time the inhibit is inserted.

6.3.2.10.2 Safety-Critical Circuits Redundancy

The Rack independent instruments shall meet the safety-critical circuits redundancy requirements defined in NSTS 18798,ET12-90-115. **[SSP 57000C, paragraph 3.2.5.1.2]**

6.3.2.10.3 Power Switches/Controls

A. Switches/controls performing on/off power functions for rack independent instruments shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position. **[SSP 57000C, paragraph 3.2.5.3.A]**

B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. **[SSP 57000C, paragraph 3.2.5.3.B]**

C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition. **[SSP 57000C, paragraph 3.2.5.3.C]**

6.3.2.10.4 Ground Fault Circuit Interrupters (GFCI)/Portable Equipment DC Sourcing Voltage

A. Rack independent instrument utility outlets with output voltages exceeding 30 volts rms or DC nominal (32 volts rms or DC maximum) intended to supply power to portable equipment shall include a GFCI, as an electrical hazard control, in the power path to the portable equipment. **[SSP 57000C, paragraph 3.2.5.4.A]**

B. GFCI trip current DC detection shall be independent of the portable equipment's safety (green) wire. **[SSP 57000C, paragraph 3.2.5.4.B]**

C. GFCI trip current AC detection shall be dependent on the portable equipment's safety (green) wire when the safety (green) wire is present. **[SSP 57000C, paragraph 3.2.5.4.C]**

D. Rack independent instruments that generate internal voltages greater than 30 volts or DC nominal (32 volts rms or DC maximum) and has a credible fault path or return path to a crew member shall include GFCI protection for that credible path with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table 6.3.2.10.4–1. **[SSP 57000C, paragraph 3.2.5.4.D]**

E. GFCI will be designed to trip below the threshold of let-go based upon the 99.5 percentile rank of adults. Rack independent instrument utility outlets shall include a GFCI with trip point characteristics such that tripping will not exceed the currents specified in the profile shown in Table 6.3.2.10.4–1. **[SSP 57000C, paragraph 3.2.5.4.E]**

F. GFCIs shall remove power within 25 milliseconds upon encountering the fault current. **[SSP 57000C, paragraph 3.2.5.4.F]**

G. GFCI shall provide an on-orbit method for testing trip current detection threshold at DC and at a frequency within the maximum human sensitivity range of 15 to 70 Hertz. **[SSP 57000C, paragraph 3.2.5.4.G]**

Note: The definitions of hazard requirements are specified in NSTS 1700.7B, ISS Addendum, paragraph 200.

TABLE 6.3.2.10.4–1. LET-GO CURRENT PROFILE THRESHOLD VERSUS FREQUENCY

Frequency	**Maximum Total Peak Current (AC + DC components combined) milliamperes**
DC	40.0
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
10000	24.3
50000	24.3
(Based on 99.5 Percentile Rank of Adults)	

[SSP 57000C, TABLE 3.2.5.4–1]

6.3.2.10.5 Portable Equipment/Power Cords

A. Non-battery powered rack independent instruments shall incorporate a three-wire power cord; e.g., a 120 volt supply lead (+), a 120 volt return (–) lead and a safety (green) wire, one end connected to the rack independent instrument chassis (and all exposed conductive surfaces) and the other end connected to structure at the GFCI location through the GFCI interface. A system of double insulation or its equivalent, when approved by NASA, may be used without a ground wire. **[SSP 57000C, paragraph 3.2.5.5.A]**

B. Fault currents resulting from a single failure within a non-battery powered rack independent instruments shall not exceed the total peak currents specified in Table 6.3.2.10.4–1 for fault current frequencies of 15 Hertz and above. **[SSP 57000C, paragraph 3.2.5.5.B]**

6.3.3 Command and Data Handling Requirements

The following requirements are defined for compatibility with HRF Common Software on the HRF portable computer.

6.3.3.1 Word/Byte Notations, Types and Data Transmissions

6.3.3.1.1 Word/Byte Notations

HRF rack independent instruments shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. **[SSP 57000C, paragraph 3.3.2.1]**

6.3.3.1.2 Data Types

HRF rack independent instruments shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. **[SSP 57000C, paragraph 3.3.2.2]**

6.3.3.2 HRF Software Requirements

A. File pathnames required for proper execution of the software shall be read from a configuration file rather than "hard coded" in the software. **[Derived]**

B. The rack independent instrument software shall execute in the environment described in the host system IDD. (Workstation, Laptop, Common Software) **[Derived]**

C. The Rack independent instrument software executables shall generate consistent results given the same initialization data. **[Derived]**

D. User interface software shall comply with the Display and Graphics Commonality Standards (DGCS) (http://139.169.159.8/idags/dgcs.html) and the International Space Station Operations United States Payload Operations Data File Payload Display Implementation Plan. **[Derived]**

E. Real-time data shall be formatted in accordance with the Life Sciences Data System (LSDS) format. **[Derived]**

6.3.3.3 ISS C&DH Services Through HRF Common Software Interface

Rack independent instruments obtaining HRF rack and Payload MDM services (e.g., ancillary data requests, file transfer, report health and status, etc.) through the HRF Common Software shall request services in accordance with LS-71062-8, Interface Definition Document for the Human Research Facility Common Software. **[Derived]**

6.3.4 <u>Thermal Control Requirements</u>

6.3.4.1 Instrument Surface Temperature

Rack independent instruments shall be designed such that the average surface temperature is less than 37 °C (98.6 °F) with a maximum temperature limit not to exceed 45 °C (113 °F). **[SSP 57000C, paragraph 3.5.1.11]**

6.3.4.2 Cabin Air Heat Leak

Cabin air heat rejection is defined by the ISS program in terms of ISS modules only. No sub-allocation has been made for integrated racks or rack independent instruments. Rack independent instrument maximum cabin air heat rejection must documented in the instrument unique ICD.

6.3.4.3 Cabin Air Cooling

Rack independent instruments air heat load absorption shall be no greater than the maximum values listed in Table 6.3.4–1, Air Heat Load, with linear interpolation to ambient temperatures between the specified values. **[SSP 57000C, paragraph 3.5.1.13]**

TABLE 6.3.4–1. AIR HEAT LOAD

AMBIENT TEMPERATURE	**MAX HEAT LOAD**
15.5 °C (60 °F)	68 W
49 °C (120 °F)	140 W

6.3.5 <u>Payload Support Services Interfaces Requirements</u>

6.3.5.1 Potable Water

6.3.5.1.1 Potable Water Interface Connection

Rack independent instruments that connect to the ISS potable water interface shall be compatible with a 683-16348, category 7, keying D fluid connector. **[SSP 57000C, paragraph 3.8.1.1, Table 3.1.1.6.1 item V]**

Payload-provided containers used to convey water from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be compatible with the Orbiter water interfaces.

6.3.5.1.2 Potable Water Interface Pressure

Instrument provided containers, and all tubing, hoses and connectors used to connect to the ISS potable water interface shall not visibly leak when exposed to the ISS potable water interface pressure of 103.4 to 206.8 kPa gauge pressure (15 to 30 psig). **[SSP 57000C, paragraph 3.8.1.2]**

6.3.5.1.3 Potable Water Use

A. Rack independent instruments use of water from the ISS water system that is not returned to the cabin air as humidity shall not exceed a daily average of 2.2 kg/day (4.8 lbm/day) based upon weekly usage. [SSP 57000C, paragraph 3.8.1.3.A]

B. The total use of water by the rack independent instruments from the ISS water system, including all water returned to the cabin air as humidity, shall not exceed a daily average of 5.51 kg/day (12.15 lbm/day) based upon weekly usage. [SSP 57000C, paragraph 3.8.1.3.B]

Payload water use from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be limited by fuel-cell water reserves available from the Orbiter after crew habitability needs have been addressed.

6.3.5.2 Fluid System Servicer

Rack independent instruments that use the FSS shall meet the physical and functional interfaces depicted in Figure 1 of the FSS Interface Definition Drawing (IDD), 683-17103. **[SSP 57000C, paragraph 3.8.2]**

6.3.6 <u>Environment Interface Requirements</u>

6.3.6.1 Atmosphere Requirements

6.3.6.1.1 Pressure

Rack independent instruments shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia). **[SSP 57000C, paragraph 3.9.1.1]**

6.3.6.1.2 Temperature

Rack independent instruments shall be safe when exposed to temperatures of 10 to 46 °C (50 to 115 °F). **[SSP 57000C, paragraph 3.9.1.2]**

6.3.6.1.3 Humidity

Rack independent instruments shall be designed to not cause condensation when exposed to a dewpoint of 4.5 to 15.6 °C (40 to 60 °F) and a relative humidity of 25 to 75% except when condensation is an intended operation of the rack independent instrument. **[SSP 57000C, paragraph 3.9.1.3]**

6.3.6.2 Rack Independent Instrument Use of Cabin Atmosphere

6.3.6.2.1 Active Air Exchange

Active air exchange with the cabin atmosphere by rack independent instruments shall be limited to air exchange for specimen metabolic purposes and for mass conservation purposes. **[SSP 57000C, paragraph 3.9.2.1.A]**

6.3.6.2.2 Oxygen Consumption

Oxygen consumption is defined by ISS for integrated racks only. Maximum leakage rate must be documented in the instrument ICD.

6.3.6.2.3 Chemical Releases

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.9.2.3]**

6.3.6.3 Ionizing Radiation Requirements

6.3.6.3.1 Instrument Contained or Generated Ionizing Radiation

Rack independent instruments containing or using radioactive materials or that generate ionizing radiation shall comply with NSTS 1700.7B, ISS Addendum, paragraph 212.1. **[SSP 57000C, paragraph 3.9.3.1]**

6.3.6.3.2 Ionizing Radiation Dose

Rack independent instruments should expect a total dose (including trapped protons and electrons) of 30 Rads (Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC–TN–9550) may show ionizing radiation exposure to be different than 30 Rads(Si) per year, if the intended location of the rack in the ISS is known.

6.3.6.3.3 Single Event Effect (SEE) Ionizing Radiation

Rack independent instruments shall be designed not to produce an unsafe condition or one that could cause damage to equipment external to the rack independent instrument as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils). **[SSP 57000C, paragraph 3.9.3.3]**

6.3.6.3.4 Additional Environmental Conditions

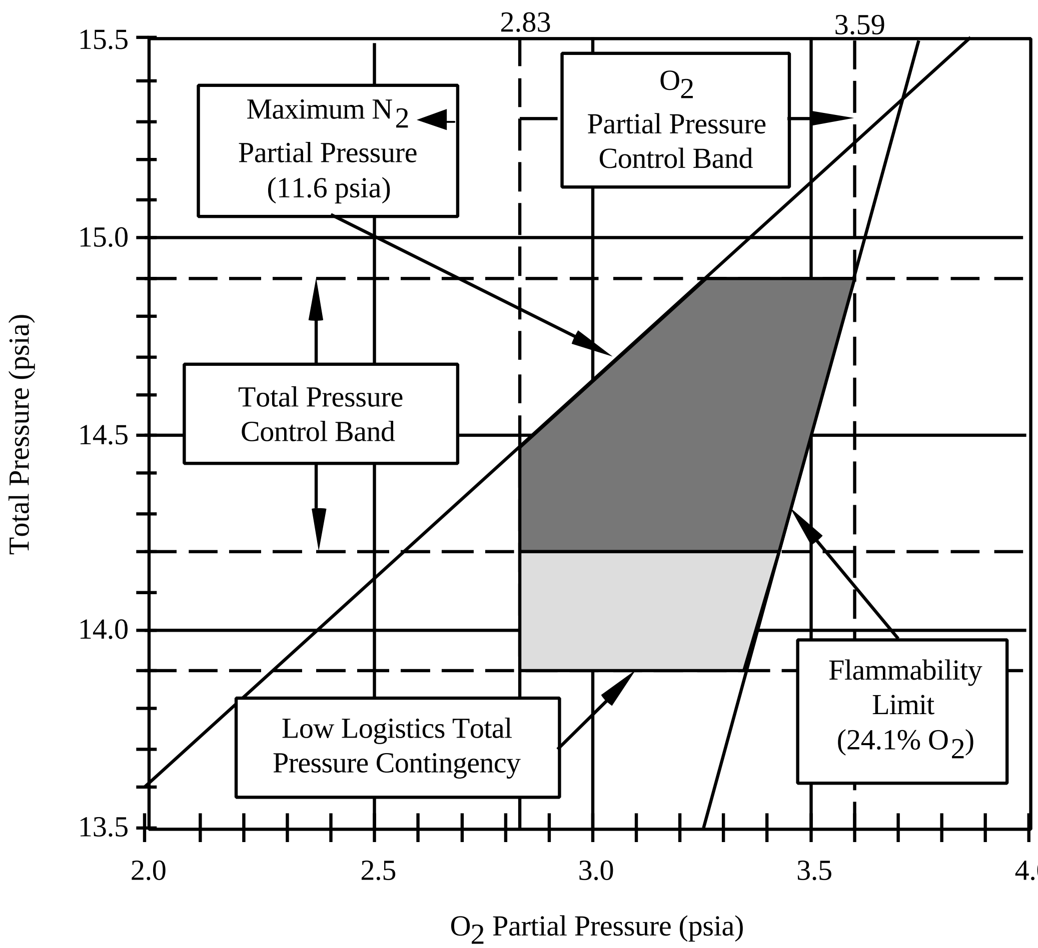
The environmental information provided in Table 6.3.6–1, Environmental Conditions on ISS, and Figure 6.3.6-1, Operating Limits of the ISS Atmospheric Total Pressure and Nitrogen and Oxygen Partial Pressures, is for design and analysis purposes.

TABLE 6.3.6–1. ENVIRONMENTAL CONDITIONS ON ISS

Environmental Condition	Value
Atmospheric Conditions	
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)
Normal operating pressure	See Figure 3.9.3.4-1
Oxygen partial pressure	See Figure 3.9.3.4-1
Nitrogen partial pressure	See Figure 3.9.3.4-1
Dewpoint	4.4 to 15.6 °C (40 to 60 °F)
Percent relative humidity	25 to 75
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mm Hg Peak exposure 10 mm Hg
Cabin air temperature in USL, JEM, APM, and CAM	17 to 28 °C (63 to 82 °F)
Cabin air temperature in Node 1	17 to 31 °C (63 to 82 °F)
Air velocity	0.051 to 2.03 m/s (10 to 40 ft/min)
Airborne microbes	Less than 1000 CFU/m^3
Atmosphere particulate level	Average less than 1000,000 particles/ft^3 for particles less than 0.5 microns in size
MPLM Air Temperatures	**Active Flights**
Pre-Launch	14 to 30 °C (57.2 to 86 °F)
Launch/Ascent	20 to 30 °C (68 to 86 °F)
On-orbit (Cargo Bay + Deployment)	16 to 46 °C (60.8 to 114.8 °F)
On-orbit (On-Station)	16 to 43 °C (63 to 109.4 °F)
On-orbit (Retrieval + Cargo Bay)	11 to 45 °C (63 to 113 °F)
Descent/Landing	10 to 42 °C (50 to 107.6 °F)
Post-Landing	10 to 42 °C (50 to 107.6 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
	Passive Flights
Pre-Launch	15 to 24 °C (59 to 75.2 °F)
Launch/Ascent	14 to 24 °C (57.2 to 75.2 °F)
On-orbit (Cargo Bay + Deployment)	24 to 44 °C (75.2 to 111.2 °F)
On-orbit (On-Station)	23 to 45 °C (73.4 to 113 °F)
On-orbit (Retrieval + Cargo Bay)	17 to 44 °C (62.6 to 111.2 °F)
Descent/Landing	13 to 43 °C (55.4 to 109.4 °F)
Post-Landing	13 to 43 °C (55.4 to 109.4 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
Thermal Conditions	
USL module wall temperature	13 °C to 43 °C (55 °F to 109 °F)
JEM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
APM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
CAM module wall temperature	13 °C to 43 °C (55 °F to 109 °F) **TBR**
Other integrated payload racks	Front surface less than 37 °C (97 °F)
***Microgravity**	
Quasi-Steady State Environment	See Figures 3.9.3.4-2, 3.9.3.4-3 and Table 3.9.3.4-2
Vibro-acoustic Environment	See Figure 3.9.3.4-4
General Illumination	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle

*Note: Data reflects best available information as of May, 1997. Does not include effects of CAM.

[SSP 57000C, TABLE 3.9.3.4–1]



[SSP 57000C, FIGURE 3.9.3.4–1]

Figure 6.3.6–1. Operating Limits of the ISS Atmospheric Total Pressure, and Nitrogen and Oxygen Partial Pressures

6.3.7 Fire Protection Interface Requirements

Fire detection requirements for instruments operated outside of rack volumes have not been defined by ISS. Fire detection methodology for instruments operated outside of rack volumes must be approved by the PSRP. Fire protection requirements in this section apply to all instruments. Fire suppression requirements in this section apply for instruments operated outside of the rack volume that have forced air flow.

6.3.7.1 Fire Prevention

HRF rack independent instruments shall meet the fire prevention requirements specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10a. **[SSP 57000C, paragraph 3.10.1]**

6.3.7.2 Fire Suppression

6.3.7.2.1 Portable Fire Extinguisher

A. HRF rack independent instruments with forced air flow that have a panel thickness less than or equal to 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 3.1.1.4–1. **[SSP 57000C, paragraph 3.10.3.1.A]**

B. HRF rack independent instruments with forced air flow that have a panel thickness greater than 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 6.1.1.4–1. **[SSP 57000C, paragraph 3.10.3.1.B]**

Note 1: The final determination of whether or not a payload volume contains a potential fire source and requires a PFE access port will be presented to and approved by the PSRP during the phased safety reviews.

Note 2: The ISS PFE has an "open cabin" diffuser nozzle which will be used to surround fire events that are not in an enclosed volume with suppressant.

Note 3: Internal volumes are volumes presented to and approved by the PSRP as sealed containers do not require PFE access ports.

6.3.7.2.2 Fire Suppression Access Port Accessibility

Rack dependent instruments requiring an access port shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figure 6.4.4.1.1–1 so the PFE nozzle can interface to the PFE port. **[SSP 57000C, paragraph 3.10.3.2]**

6.3.7.2.3 Fire Suppressant Distribution

The internal layout of HRF rack independent instruments shall allow ISS PFE fire suppressant to be distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. **[SSP 57000C, paragraph 3.10.3.2]**

Note: The position of HRF rack independent instruments components near the PFE Access Port should not prevent fire suppressant to be discharged into the volume the PFE Access Port serves. PFE discharge characteristics are specified in Figure 6.1.1.4–1 and PFE closed volume nozzle dimensions are specified in Figure 6.4.4.1.1–2.

6.3.7.3 Labeling

HRF rack independent instruments requiring an access port shall label the PFE access port with a SDD32100397–002 “Fire Hole Decal” specified in JSC 27260, “Decal Process Document and Catalog”. **[SSP 57000C, paragraph 3.10.4.A]**

6.3.8 Materials and Parts Interface Requirements

6.3.8.1 Materials and Parts Use and Selection

HRF rack independent instruments shall use materials and parts that meet the materials requirements specified in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.11.1]**

6.3.8.2 Commercial Parts

COTS parts used in HRF rack independent instruments shall meet the materials requirements specified in NSTS 1700.7B, ISS Addendum. **[SSP 57000C, paragraph 3.11.1.1]**

6.3.8.3 Cleanliness

HRF rack independent instruments shall conform to Visibly Clean-Sensitive (VC–S) cleanliness requirements as specified in SN–C–0005. **[SSP 57000C, paragraph 3.11.3]**

6.3.8.4 Fungus Resistant Material

HRF rack independent instruments that are intended to remain on-orbit for more than one year shall use fungus resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10. **[SSP 57000C, paragraph 3.11.4]**

6.4 HUMAN FACTORS REQUIREMENTS

This section contains the set of human factor requirements specified in SSP 57000 that are generically applied by the ISS program to all payload hardware design. The subset of requirements applicable to specific rack or instrument designs must be documented in each rack or instrument unique SRD and ICD.

Note: For configuration management purposes, requirement text defined in SSP 57000 is documented here verbatim, with the one exception. Paragraph, figure and table numbers specified in SSP 57000 requirement text that are contained in this document have been changed to conform to the numbering structure of this document. No corrections to spelling, punctuation, first occurrence or use of acronyms have been made.

6.4.1 Strength Requirements

6.4.1.1 Operation and Control of Payload Equipment

A. Grip Strength

To remove, replace and operate payload hardware, grip strength required shall be less than 254 N (57lbf). **[SSP 57000C, paragraph 3.12.1.A.1]**

B. Linear Forces

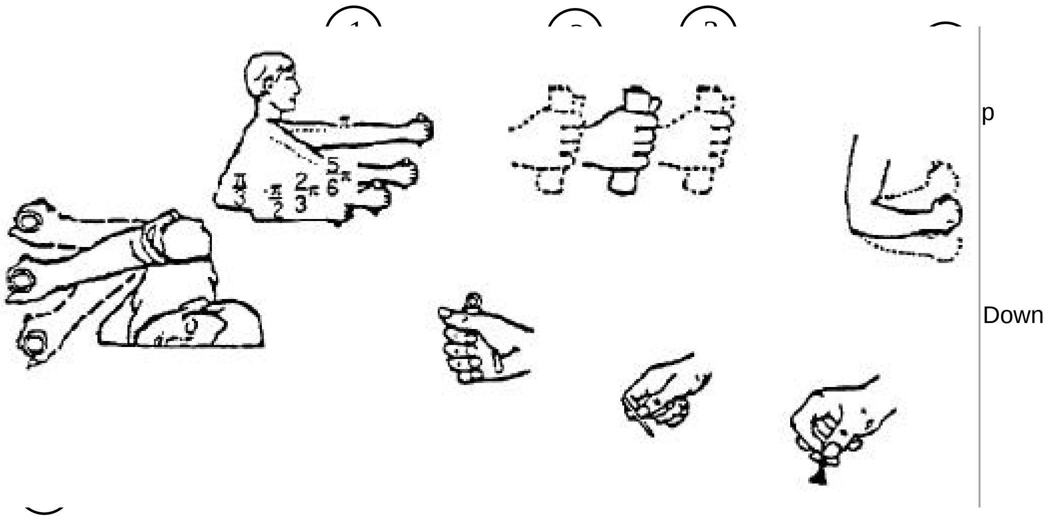
Linear forces required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 50% of the strength values shown in Figure 6.4.1–1 and 60% of the strength values shown in Figure 6.4.1–2. **[SSP 57000C, paragraph 3.12.1.A.2]**

C. Torque

Torque required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 60% of the calculated 5th percentile male capability shown in Figure 6.4.1–3. **[SSP 57000C, paragraph 3.12.1.A.3]**

6.4.1.2 Maintenance Operations

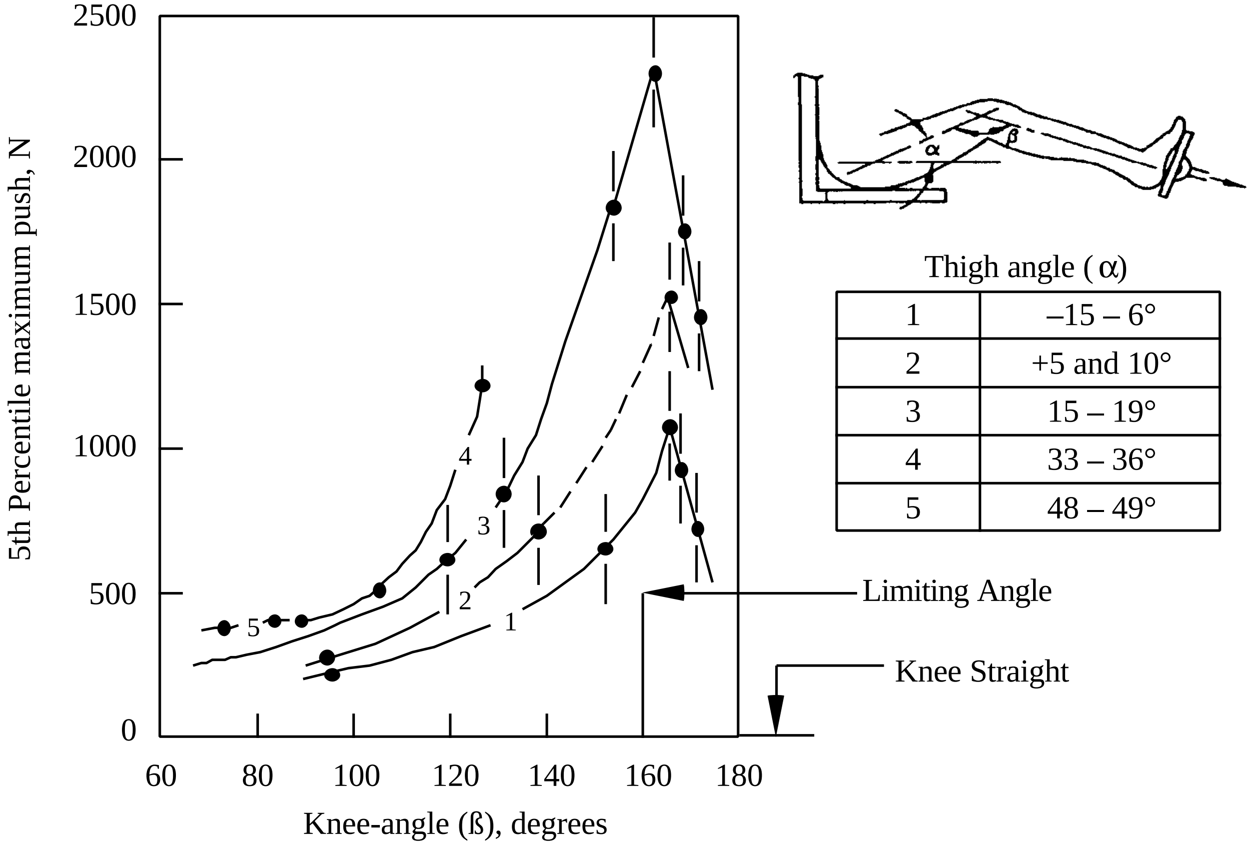
Forces required for maintenance of payload hardware and equipment shall be less than the 5th percentile male strength values shown in Figures 6.4.1–1, 6.4.1–2, 6.4.1–3, 6.4.1–4, and 6.4.1–5. **[SSP 57000C, paragraph 3.12.1.B]**



Arm Strength												
(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (rad)	Pull		Push		Up		Down		In		Out	
	L**	R**	L	R	L	R	L	R	L	R	L	R
?	222	231	187	222	40	62	58	76	58	89	36	82
5/6 ?	187	249	133	187	67	80	80	89	67	89	36	87
2/3 ?	151	187	116	160	76	107	93	116	89	98	45	87
1/2 ?	142	165	98	160	76	78	93	116	71	80	45	71
1/3 ?	116	107	96	151	67	89	80	89	76	89	53	78
Hand and thumb-finger strength (N)												
	(8)				(9)				(10)			
	Hand Grip											
	L		R		Thumb-finger grip (Palmer)				Thumb-finger grip (tips)			
Momentary hold Sustained hold	250 145		250 155		60 35				60 35			
*Elbow angle shown in radians **L = Left, R = Right												
Arm strength (lb)												
(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (rad)	Pull		Push		Up		Down		In		Out	
	L	R*	L	R	L	R	L	R	L	R	L	R
180	50	52	42	50	9	14	13	17	13	20	8	14
150	42	56	30	42	15	18	18	20	15	20	8	15
120	34	42	26	36	17	24	21	26	20	22	10	15
90	32	37	22	36	17	20	21	26	16	18	10	16
60	25	24	22	34	15	20	18	20	17	20	12	17
Hand and thumb-finger strength (lb)												
	(8)				(9)				(10)			
	Hand Grip											
	L		R		Thumb-finger grip (Palmer)				Thumb-finger grip (tips)			
Momentary hold Sustained hold	56 33		39 35		13 8				13 8			
*Left; R = Right												

[SSP 57000C, FIGURE 3.12.1-1]

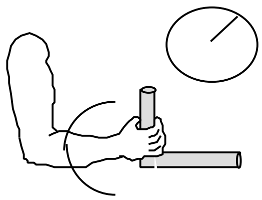
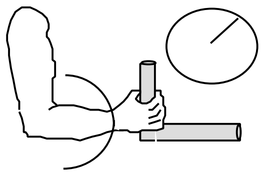
Figure 6.4.1–1. Arm, Hand, and Thumb/Finger Strength (5th Percentile Male Data)



1	–15 – 6°
2	+5 and 10°
3	15 – 19°
4	33 – 36°
5	48 – 49°

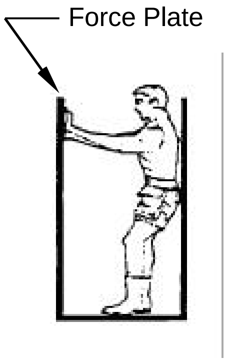
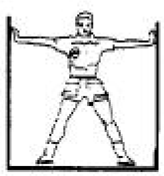
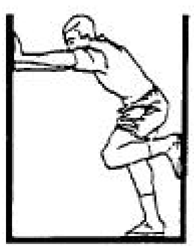
[SSP 57000C, FIGURE 3.12.1-2]

Figure 6.4.1–2. Leg Strength at Various Knee and Thigh Angles (5th Percentile Male Data)

	Unpressurized suit, bare handed	
	Mean	SD
 Maximum torque: Suppination, Nm (lb.-in.)	13.73 (121.5)	3.41 (30.1)
 Maximum torque: Pronation, Nm (lb.-in.)	17.39 (153.9)	5.08 (45.0)

[SSP 57000C, FIGURE 3.12.1-3]

Figure 6.4.1–3. Torque Strength

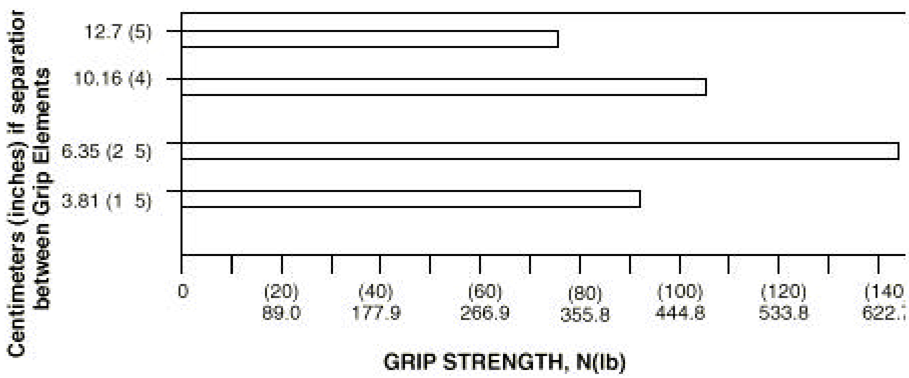
1.0.1.1.89	1.0.1.1.90 Force-plate (1)	1.0.1.1.91	1.0.1.1.92 Force, N (lbf)	
1.0.1.1.93	1.0.1.1.94 height	1.0.1.1.95 Distances (2)	1.0.1.1.96 Means	1.0.1.1.97 SD
	1.0.1.1.98 100 percent of shoulder height	1.0.1.1.99 50 60 70 80 90 100 50 60 70 80 90 100 Percent of thumb-tip reach*	1.0.1.1.100 Both 583 (131) 667 (150) 983 (221) 1285 (289) 979 (220) 645 (145) Preferred 262 (59) 298 (67) 360 (81) 520 (117) 494 (111) 427 (96)	1.0.1.1.101 hands 142 (32) 160 (35) 271 (61) 400 (50) 382 (68 254 (57) hand 67 (15) 71 (16) 98 (22) 142 (32) 169 (38) 173 (35)
	1.0.1.1.102 100 percent of shoulder height	1.0.1.1.103 50 60 70 80 90 Percent of span**	1.0.1.1.104 369 (83) 347 (78) 520 (117) 707 (159) 325 (73)	1.0.1.1.105 138 (31) 125 (28) 165 (37) 191 (32) 133 (35)
1.0.1.1.106	1.0.1.1.107 Force-plate (1)	1.0.1.1.108	1.0.1.1.109 Force, N (lbf)	
1.0.1.1.110	1.0.1.1.111 height	1.0.1.1.112 Distances (2)	1.0.1.1.113 Means	1.0.1.1.114 SD
	1.0.1.1.115 50 50 70 Percent of	1.0.1.1.116 100 120 120 shoulder height	1.0.1.1.117 774 (174) 778 (175) 818 (184) 1-g applicable	1.0.1.1.118 214 (48) 165 (37) 138 (31) data

NOTES:

(1) Height of the center of the force plate - 200 mm (8 in) high by 254 mm (10 in) long - upon which force is applied.
(2) Horizontal distance between the vertical surface of the force plate and the opposing vertical surface (wall or footrest, respectively) against which the subject brace themselves.
() Thumb-tip reach - distance from backrest to tip of subject’s thumb as thumb and fingertips are pressed together.
() Span - the maximal distance between a person’s fingertips as he extends his arms and hands to each side.
(3) 1-g data.

[SSP 57000C, FIGURE 3.12.1-4]

Figure 6.4.1–4. Maximal Static Push Forces



[SSP 57000C, FIGURE 3.12.1-5]

Figure 6.4.1–5. Male Grip Strength as a Function of the Separation Between Grip Elements

6.4.2 <u>Body Envelope and Reach Accessibility</u>

6.4.2.1 Adequate Clearance

The payloads shall provide clearance for the crew to perform installation, operations, and maintenance tasks, including clearance for hand access, tools and equipment used in these tasks. **[SSP 57000C, paragraph 3.12.2.1]**

6.4.2.2 Accessibility

A. Payload hardware shall be geometrically arranged to provide physical and visual access for all payload installation, operations, and maintenance tasks. Payload ORUs should be removable along a straight path until they have cleared the surrounding structure. **[SSP 57000C, paragraph 3.12.2.2.A]**

B. IVA clearances for finger access shall be provided as given in Figure 6.4.2.2–1. **[SSP 57000C, paragraph 3.12.2.2.B]**

Minimal finger-access to first joint			
Push button access:	Bare hand: Thermal gloved hand:	32 mm dia (1.26 in.) 38 mm dia (1.5 in.)	
Two finger twist access:	Bare hand: Thermal gloved hand:	object plus 50 mm (1.97 in.) object plus 65 mm (2.56 in.)	

[SSP 57000C, FIGURE 3.12.2.2–1]

Figure 6.4.2.2–1. Minimum Sizes for Access Openings for Fingers

6.4.2.3 Full Size Range Accommodation

All payload workstations and hardware having crew nominal operations and planned maintenance shall be sized to meet the functional reach limits for the 5th percentile Japanese female and yet shall not constrict or confine the body envelope for the 95th percentile American male as specified in SSP 50005, section 3. **[SSP 57000C, paragraph 3.12.2.3]**

6.4.3 Habitability

6.4.3.1 Housekeeping

6.4.3.1.1 Closures or Covers

Closures or covers shall be provided for any area of the payload that is not designed for routine cleaning. **[SSP 57000C, paragraph 3.12.3.1.1]**

6.4.3.1.2 Built-In Control

A. Payload containers of liquids or particulate matter shall have built-in equipment/methods for control of vaporization, material overflow, or spills. **[SSP 57000C, paragraph 3.12.3.1.2.A]**

B. The capture elements, including grids, screens, or filter surfaces shall be accessible for replacement or cleaning without dispersion of the trapped materials. **[SSP 57000C, paragraph 3.12.3.1.2.B]**

6.4.3.1.3 One-Handed Operation

Cleaning equipment and supplies shall be designed for one-handed operation or use. **[SSP 57000C, paragraph 3.12.3.1.5]**

6.4.3.1.4 Surface Materials

Materials used for exposed interior surfaces shall be selected to preclude particulate and microbial contamination and shall be smooth, solid, and non–porous. **[SSP 57000C, paragraph 3.12.3.1.6]**

6.4.3.2 Touch Temperature

6.4.3.2.1 Continuous/Incidental Contact - High Temperature

When payload surfaces whose temperature exceeds 49 °C (120 °F), which are subject to continuous or incidental contact, are exposed to crewmember's bare skin contact, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2–95–048. **[SSP 57000C, paragraph 3.12.3.2.1]**

6.4.3.2.2 Continuous/Incidental Contact – Low Temperature

When payload surfaces below –18 °C (0 °F), which are subject to continuous or incidental contact, are exposed to crewmember's bare skin contact, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2–95–048. **[SSP 57000C, paragraph 3.12.3.2.2]**

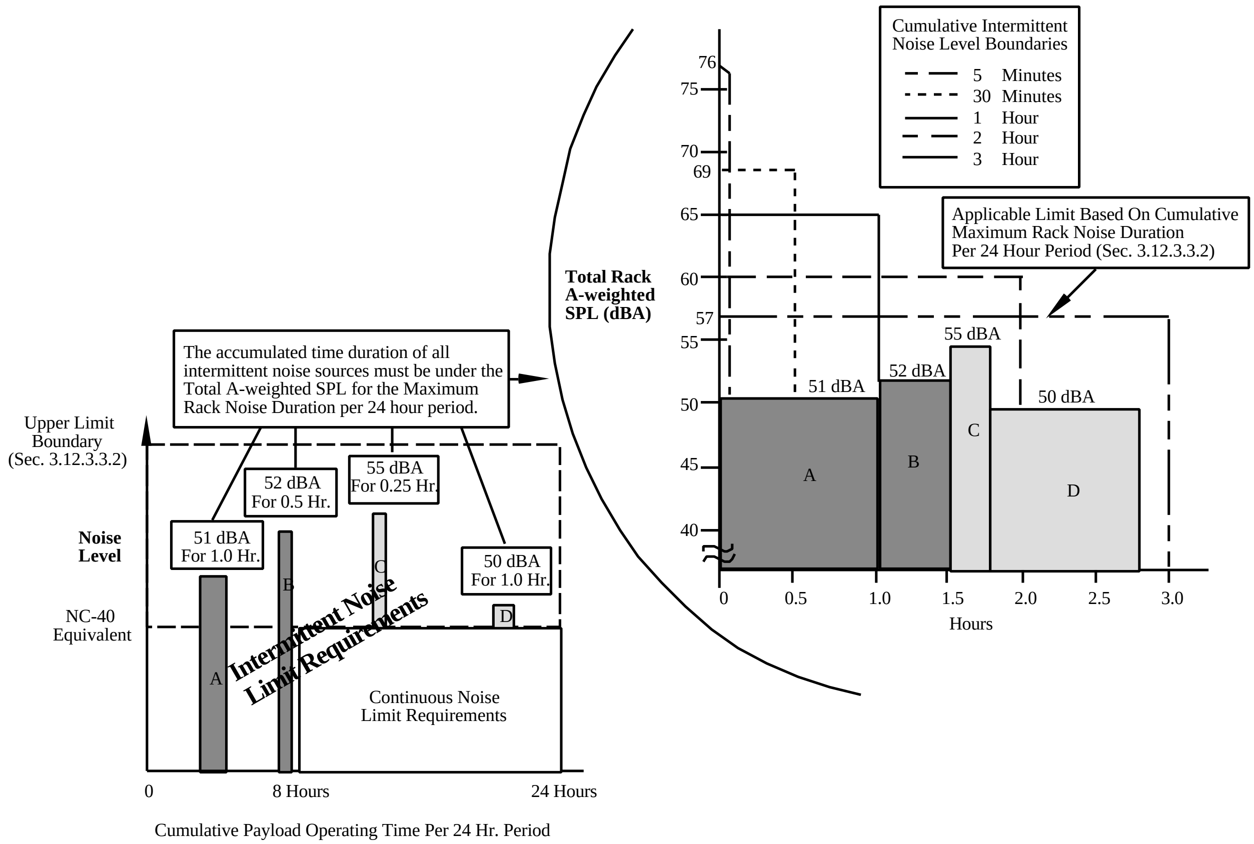
6.4.3.3 Acoustic Requirements

An Integrated Rack will not be allowed to operate above NC–40 except in those cases when it meets the Intermittent Noise Source requirements specified in section 6.4.3.3.2.

Due to the multitude of payload operations, an integrated rack may exhibit multiple acoustic noise source characteristics. These characteristics affect the requirements an integrated rack must satisfy in order to operate on-orbit.

For example, an integrated rack which operates less than eight hours in any one 24 hour period and generates a SPL equal to or in excess of 37 dBA measured at 0.6 meter distance from the noisiest part of the rack, is an Intermittent Noise Source. An integrated rack which produces intermittent noise will need to ensure the cumulative time it generates intermittent noise within a 24 hour period satisfies the Intermittent Noise Limit requirements. An integrated rack which operates for more than eight hours in a 24 hour period and generates a SPL equal to or in excess of 37 dBA measured at 0.6 meter distance from the noisiest part of the rack is a Continuous Noise Source. An integrated rack which produces continuous noise will be allowed to operate under certain conditions: 1.) if the integrated rack's noise level always stays below NC–40, or 2.) if the cumulative time it generates noise above NC–40 during a 24 hour period satisfies the Intermittent Noise Limit requirements (see Figure 6.4.3.3–1).

Each Integrated Rack will submit an Acoustics Noise Control Plan (ANCP). The ANCP will identify all testing and analysis required to manage the noise produced by the rack throughout its operational life span on the ISS.



[SSP 57000C, FIGURE 3.12.3.3–1]

Figure 6.4.3.3–1. Intermittent Noise Limit Requirements

The acoustic limits that will be utilized are provided in the Tables which follow. The limits apply to the integrated rack and to any sub-rack equipment that is independently operated outside of the rack. The Integrated rack configuration includes any adjunct equipment such as payload-provided external computers, fans, etc., added in support of the rack system.

Note: Integrated racks unable to meet the acoustic design requirements will be required to take Sound Power measurements to process any proposed exceptions.

Any required acoustic measurements will be performed in accordance with the appropriate standards, as follows:

ISO 9614–2, Acoustics – Determination of Sound Power Levels of Noise Sources using Sound Intensity – Part 2: Measuring by Scanning, (1996).

ANSI S1.4, Specification for Sound Level Meters Amendment S1.4A–1985 ASA 47 R (1994).

ANSI S1.11, Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters; ASA 65–1986 R (1993).

ANSI S12.12–1992, Engineering Method for the Determination of Sound Power Levels of Noise Sources using Sound Intensity ASA 104.

ANSI S12.23–1989 (R1996), Method for the Designation of Sound Power Emitted by Machinery and Equipment.

ANSI S12.31–1990 (R1996), Precision Methods for Determination of Sound Power Levels of Broad-band Noise Sources in Reverberation Rooms.

ANSI S12.32–1990 (R1996), Precision Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow-band Noise Sources in Reverberation Rooms.

ANSI S12.33–1990, Engineering Methods for the Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room.

ANSI S12.34–1988 (R1993), Engineering Methods for the Determination Sound Power Levels of Noise Sources for Essentially Free-field Conditions over a Reflecting Plane.

ANSI–S12.35–1990 (R1996), Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi-anechoic Rooms.

ANSI–S12.36–1990, Survey Methods for the Determination of Sound Power Levels of Noise Sources.

6.4.3.3.1 Continuous Noise Limits

A. Integrated Racks Whose Sub-Rack Equipment Will Not Be Changed Out

The Continuous Noise Source (see Glossary of Terms) for an integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) whose sub-rack equipment will not be changed out on-orbit shall not, except in those cases when the rack meets the Intermittent Noise Source requirements specified in section 6.4.3.3.2, exceed the limits specified in Table 6.4.3.3.1–1 for all octave bands (NC–40 equivalent) when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under nominal crew, or hardware operation circumstances, during integrated rack setup operations, or during nominal operations where doors/panels are opened or removed.

Note: These acoustic requirements do not apply during failure or maintenance operations. **[SSP 57000C, paragraph 3.12.3.3.1.A]**

B. Integrated Racks Whose Sub-Rack Equipment Will Be Changed Out

The Continuous Noise Source (see Glossary of Terms) for an integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) whose sub-rack equipment will be changed out on-orbit shall not, except in those cases when the rack meets the Intermittent Noise Source requirements specified in section 6.4.3.3.2, exceed the limits specified in Table 6.4.3.3.1–1 for all octave bands (NC–40 equivalent) when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under nominal crew, or hardware operation circumstances, during integrated rack setup operations, or during nominal operations where doors/panels are opened or removed. **[SSP 57000C, paragraph 3.12.3.3.1.B]**

Note: These acoustic requirements do not apply during failure or maintenance operations.

TABLE 6.4.3.3.1–1. CONTINUOUS NOISE LIMITS

RACK NOISE LIMITS MEASURED AT 0.6 METERS DISTANCE FROM THE TEST ARTICLE	
FREQUENCY BAND HZ	**INTEGRATED RACK SOUND PRESSURE LEVEL (SPL)**
63	64
125	56
250	50
500	45
1000	41
2000	39
4000	38
8000	37

[SSP 57000C, TABLE 3.12.3.3.1–1]

C. Independently Operated Equipment

Any independently operated equipment item, stowed within the rack or elsewhere, and deployed on orbit for a separate function other than that of the rack system, shall individually comply with the acoustic requirements in the Table 6.4.3.3.1–1. **[SSP 57000C, paragraph 3.12.3.3.1.C]**

6.4.3.3.2 Intermittent Noise Limits

A. The Integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) Intermittent Noise Source (See Glossary of Terms) shall not exceed the Total Rack A-weighted SPL Limits during the Maximum Rack Noise Duration as specified in Table 6.4.3.3.2–1 when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under any planned operations. **[SSP 57000C, paragraph 3.12.3.3.2]**

Note: These acoustic requirements do not apply during failure or maintenance operations.

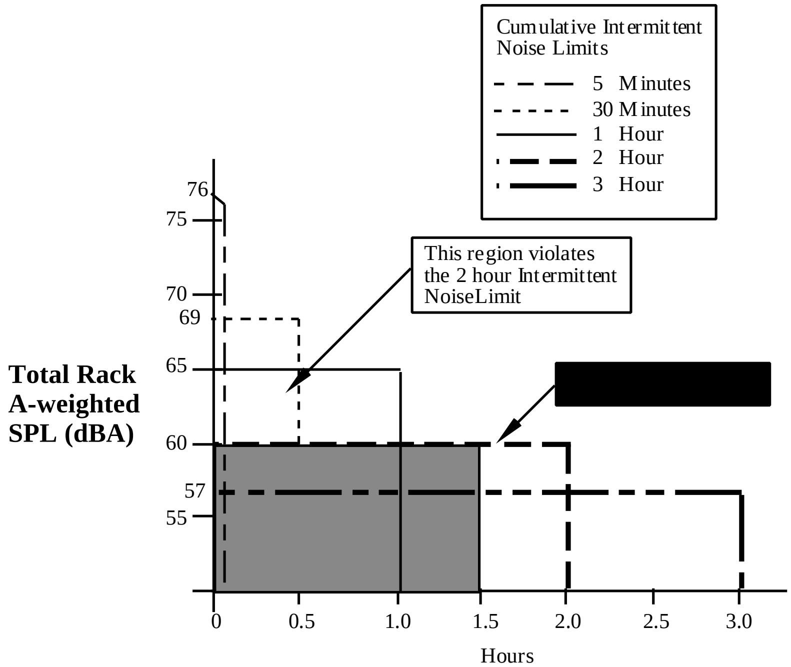
TABLE 6.4.3.3.2–1. INTERMITTENT NOISE LIMITS

RACK NOISE LIMITS MEASURED AT 0.6 METERS DISTANCE FROM THE TEST ARTICLE	
MAXIMUM RACK NOISE DURATION U	**TOTAL RACK A-WEIGHTED SPL (DBA)**
8 Hours	49
7 Hours	50
6 Hours	51
5 Hours	52
4 Hours	54
3 Hours	57
2 Hours	60
1 Hour	65
30 Minutes	69
15 Minutes	72
5 Minutes	76
2 Minutes	78
1 Minute	79
Not Allowed	80

[SSP 57000C, TABLE 3.12.3.3.2–1]

B. The Rack Noise Duration is the total time that the rack produces intermittent noise above the NC–40 limit during a 24 hour time period. This duration is the governing factor in determining the allowable Intermittent Noise Limits. Regardless of the number of separate sources and varying durations within a rack, this cumulative duration shall be used to determine the A-weighted SPL limit in column B. **[SSP 57000C, paragraph 3.12.3.3.2]**

C. For example, if a rack produces 65 dBA for 30 minutes in a start-up and warm-up mode and then settles down to 60 dBA for a one hour period of normal data acquisition, the duration is 1.5 hours. To meet the requirement, the noise can be no greater than 60 dBA, and in this case, the rack would not meet the requirement, even though two separate payloads, one that operated at 65 dBA for 30 minutes and another that operated at 60 dBA for one hour, would be acceptable (see Figure 6.4.3.3.2–1).



[SSP 57000C, FIGURE 3.12.3.3.2–1]

Figure 6.4.3.3.2–1. Intermittent Noise Limits

6.4.3.4 Lighting Design

The general illumination of the space station in the aisle will be a minimum of 108 lux (10 foot candles) of white light. This illumination will be sufficient for ordinary payload operations performed in the aisle (e.g., examining dials or panels, reading procedures, transcription, tabulation, etc.).

Payloads will meet the following requirements:

A. Payload work surface specularity shall not exceed 20 percent. Paints listed in Table 6.4.3.4–1 meet this requirement. **[SSP 57000C, paragraph 3.12.3.4.A]**

B. Lighting levels for tasks to be performed at payload worksites shall be provided, as defined in Table 6.4.3.4–2. **[SSP 57000C, paragraph 3.12.3.4.B]**

TABLE 6.4.3.4–1. SURFACE INTERIOR COLORS AND PAINTS

HARDWARE DESCRIPTION	COLOR	FINISH	PAINT SPECIFICATION PER FED-STD-595
Equipment Rack Utility Panel Recess	White	Semigloss	27925
Equipment Rack Utility Panel Text Characters	Black	Lusterless	37038
International Std. Payload Rack Primary Structure	Off-White	Semigloss	27722
ISPR Utility Panel Recess	White	Semigloss	27925
ISPR Utility Panel Recess Text Characters	Black	Lusterless	37038
Functional Unit Rack (Primary Structure)	Off-White	Semigloss	27722
Functional Unit Utility Panel Recess (as applicable)	White	Semigloss	27925
Functional Unit Utility Panel Recess Text Characters	Black	Lusterless	37038
Rack Front Aisle Extensions	Off-White	Semigloss	27722
Ceiling Rack Face Plates	Off-White	Semigloss	27722
Port Rack Face Plates	Off-White	Semigloss	27722
Starboard Rack Face Plates	Off-White	Semigloss	27722
Floor Rack Face Plates	Off-White	Semigloss	27722
Ceiling Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Port Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Starboard Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Floor Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Stowage Trays	On-White	Semigloss	27722
Stowage Tray Handle Straps (any location)	Blue material	Semigloss	25102 or equiv.
Common Seat Track Interface	Clear (Anodized)	Semigloss	none
Glovebox (Aluminum or Plastic)	Medium Gray	Gloss	16329 or 16373
Glovebox (Aluminum)	White	Gloss	17925
Glovebox (Aluminum or Plastic)	Off-White	Gloss	17722
Glovebox (Aluminum)	Tan	Gloss	10475

[SSP 57000C, TABLE 3.12.3.4–1]

TABLE 6.4.3.4–2. PAYLOAD REQUIRED ILLUMINATION LEVELS

Type of Task	Required Lux (Foot-Candles)*
Medium payload operations (not performed in the aisle) (e.g., payload change-out and maintenance)	325 (30)
Fine payload operations (e.g., instrument repair)	1075 (100)
Medium glovebox operations (e.g., general operations, experiment set-up)	975 (90)
Fine glovebox operations (e.g., detailed operations, protein crystal growth, surgery/dissection, spot illumination)	1450 (135)

* As measured at the task site

[SSP 57000C, TABLE 3.12.3.4–2]

C. Light sources shall be dimmable. **[SSP 57000C, paragraph 3.12.3.4.C]**

D. Lighting in gloveboxes, excluding spot illumination, shall not exceed a brightness ratio of 3:1. **[SSP 57000C, paragraph 3.12.3.4.D]**

E. Medium payload operational tasks shall utilize the ISS Portable Utility Light (PUL) specified in JSC 27199. **[SSP 57000C, paragraph 3.12.3.4.E]**

6.4.3.5 Color Schemes for HRF Rack Mounted and Deployed Instruments

6.4.3.5.1 Rack Mounted Equipment

SSP 50008, Rev. A, page 3-4, Table 3.2.7-1, applies to HRF rack mounted hardware. Front panels for active and stowage drawers meant for installation in HRF racks shall be off-white, specification # 27722 as given in FED-STD-595B, "Federal Standard Colors Used in Government Procurement". The finish shall be semi-gloss. SIR drawer panel handle latches are not subject to this requirement and shall be finished in accordance with the engineering drawings for the panel handle latches. **[HRF Engineering Directive, HRF-ED-001A]**

6.4.3.5.2 Stowed/Deployable Equipment

The colors and finishes for stowed and deployable equipment, even [if] it is normally attached to the rack during use shall be as specified below:

A. COTS equipment that is not repackaged by HRF engineers shall be finished as delivered by the manufacturer. **[HRF Engineering Directive, HRF-ED-001A]**

B. Items which are repackaged by HRF engineers shall be finished using anodic film per MIL-A-8625, Type II, Class 2, Dyed Turquoise. Reference FED-STD-595, Color Specification 15187. **[HRF Engineering Directive, HRF-ED-001A]**

6.4.3.5.3 Colors for Soft Goods

Human factors engineering will provide guidance on the appropriate colors for soft goods, in cooperation with the lead engineers, who will provide data on the available color choices for the specified materials. **[HRF Engineering Directive, HRF-ED-001A]**

6.4.4 Structural/Mechanical Interfaces

6.4.4.1 Hardware Protrusion Limits

6.4.4.1.1 Permanent Protrusions

Integrated rack payload hardware shall only extend beyond the NASA ISPR front face GSE attachment points as defined in SSP 41017 and agreed to by ISS in the unique payload ICDs. Payload hardware extended or attached on–orbit may protrude beyond the face of the NASA ISPR front face GSE attachment points only on an intermittent or temporary basis. Payload work corridor will be 50 inches x 72 inches, (50 inches Y axis, 72 inches Z axis). **[SSP 57000C, paragraph 3.12.4.1]**

6.4.4.1.2 Intermittent Protrusions

A. Intermittent protrusions are defined as equipment which remains setup in the aisle over a period of days, during which time crew attendance is repeatedly required. Intermittent protrusions shall be limited to 17 inches beyond the plane of the NASA ISPR front face GSE attachment points (except for payloads manifested in the floor or ceiling locations which are limited to 6 inches).

B. Intermittent protrusions shall be easily stowable. **[SSP 57000C, paragraph 3.12.4.1]**

6.4.4.1.3 Temporary Protrusions

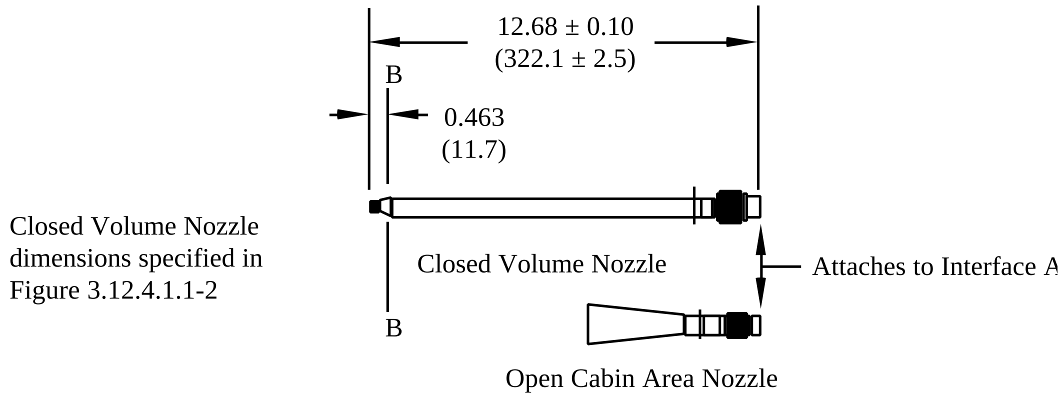
Temporary protrusions are defined as equipment which remains set up in the aisle for a period of less than eight hours, during which time crew attendance will be nearly continuous. Temporary protrusions shall be limited to 26 inches beyond the plane of the NASA ISPR front face GSE attachment points. **[SSP 57000C, paragraph 3.12.4.1]**

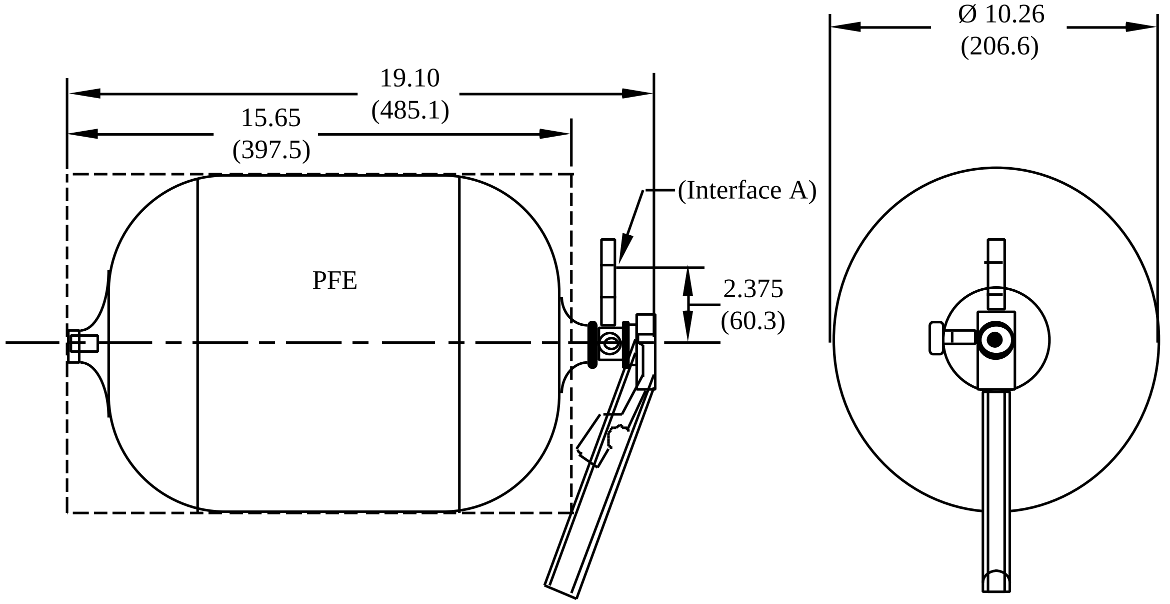
6.4.4.1.4 Clearance for Crew Restraints and Mobility Aids

Protrusions, intermittent or temporary shall not interfere with crew mobility and translation restraints. Any temporary or intermittent protrusions will create additional rack placement constraints and risks to the microgravity environment of the payload. **[SSP 57000C, paragraph 3.12.4.1]**

6.4.4.1.5 Fire Suppression Port Access

Each Integrated rack requiring an access port shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figure 6.4.4.1.1–1 so the PFE nozzle can interface to the PFE port. **[SSP 57000C, paragraph 3.10.3.2]**

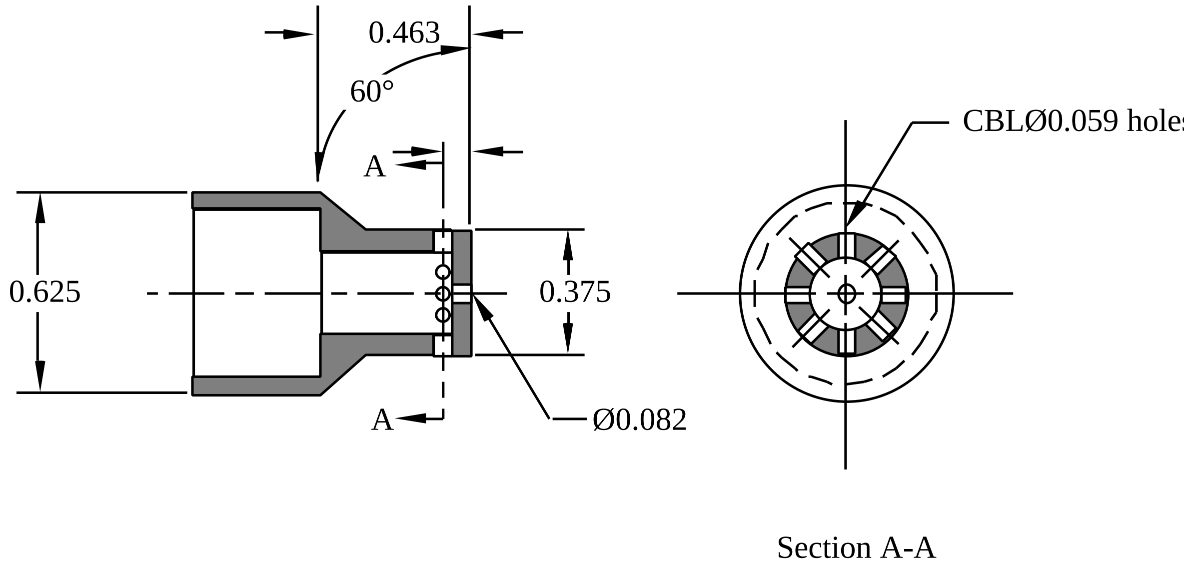




NOTE: Measurement from PFE centerline to point B with the Closed Cabin Nozzle attached is approximately 14.59 inches (370.6 mm).

[SSP 57000C, FIGURE 3.12.4.1.1–1]

Figure 6.4.4.1.1–1. Manual Fire Suppression Hardware Envelope



NOTE: Linear dimensions are in inches, angular dimensions are in degrees.
[SSP 57000C, FIGURE 3.12.4.1.1–2]

Figure 6.4.4.1.1–2. Closed Volume PFE Nozzle

6.4.4.2 Payload Hardware Mounting

6.4.4.2.1 Equipment Mounting

Equipment items used during nominal operations and planned maintenance shall be designed, labeled, or marked to protect against improper installation. **[SSP 57000C, paragraph 3.12.4.2.1]**

6.4.4.2.2 Drawers and Hinged Panels

A. Payload ORUs which are pulled out of their installed positions for routine checkout shall be mounted on equipment drawers or on hinged panels. **[SSP 57000C, paragraph 3.12.4.2.2]**

B. Such drawers or hinged panels shall remain in the “open” position without being supported by hand. **[SSP 57000C, paragraph 3.12.4.2.2]**

6.4.4.2.3 Alignment

Payload hardware having blind mate connectors shall provide guide pins or their equivalent to assist in alignment of hardware during installation. **[SSP 57000C, paragraph 3.12.4.2.5]**

6.4.4.2.4 Slide-Out Stops

Limit stops shall be provided on slide or pivot mounted sub-rack hardware which is required to be pulled out of its installed positions. **[SSP 57000C, paragraph 3.12.4.2.6]**

6.4.4.2.5 Push-Pull Force

Payload hardware mounted into a capture-type receptacle that requires a push-pull action shall require a force less than 156 N (35 lbf) to install or remove. **[SSP 57000C, paragraph 3.12.4.2.7]**

6.4.4.2.6 Access

Access to inspect or replace a hardware item [e.g., an Orbital Replacement Unit (ORU)] which is planned to be accessed on a daily or weekly basis shall not require removal of another hardware item or more than one access cover. **(SSP 57000B, paragraph 3.12.4.2.8)**

6.4.4.2.6.1 Covers

Where physical access is required, one of the following practices shall be followed, with the order of preference given. **[SSP 57000C, paragraph 3.12.4.2.8.1]**

A. Provide a sliding or hinged cap or door where debris, moisture, or other foreign materials might otherwise create a problem.

B. Provide a quick-opening cover plate if a cap will not meet stress requirements.

6.4.4.2.6.2 Self-Supporting Covers

All access covers that are not completely removable shall be self-supporting in the open position. **[SSP 57000C, paragraph 3.12.4.2.8.2]**

6.4.4.2.6.3 Unique Tools

Payload provided unique tools shall meet the requirements of SSP 50005, paragraph 11.2.3. **[SSP 57000C, paragraph 3.12.4.2.8.4]**

6.4.4.3 Connectors

6.4.4.3.1 One-Handed Operation

All ORU connectors, whether operated by hand or tool, shall be designed and placed so they can be mated/demated using either hand. **[SSP 57000C, paragraph 3.12.4.3.1]**

6.4.4.3.2 Accessibility

A. It shall be possible to mate/demate individual connectors without having to remove or mate/demate other connectors during nominal operations. **[SSP 57000C, paragraph 3.12.4.3.2.A.1]**

B. It shall be possible to mate/demate individual connectors without having to remove or mate/demate connectors on other ORUs or payloads during maintenance operations. **[SSP 57000C, paragraph 3.12.4.3.2.A.2]**

C. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors. **[SSP 57000C, paragraph 3.12.4.3.2.B]**

6.4.4.3.3 Ease of Disconnect

Electrical connectors shall require no more than two turns to disconnect. **[SSP 57000C, paragraph 3.12.4.3.3]**

6.4.4.3.4 Indication of Pressure/Flow

Payload liquid or gas lines not equipped with quick disconnect connectors which are designed to be connected/disconnected under pressure shall be fitted with pressure/flow indicators. **[SSP 57000C, paragraph 3.12.4.3.4]**

6.4.4.3.5 Self Locking

Payload electrical connectors shall provide a self-locking feature. **[SSP 57000C, paragraph 3.12.4.3.5]**

6.4.4.3.6 Connector Arrangement

A. Space between connectors and adjacent obstructions shall be a minimum of 25mm (1 inch) for IVA access. **[SSP 57000C, paragraph 3.12.4.3.6.A]**

B. Connectors in a single row or staggered rows which are removed sequentially by the crew IVA shall provide 25mm (1inch) of clearance from other connectors and/or adjacent obstructions for 270 degrees of sweep around each connector beginning at the start of its removal/replacement sequence. **[SSP 57000C, paragraph 3.12.4.3.6.B]**

6.4.4.3.7 Arc Containment

Electrical connector plugs shall be designed to confine/isolate the mate/demate electrical arcs or sparks. **[SSP 57000C, paragraph 3.12.4.3.7]**

6.4.4.3.8 Connector Protection

Protection shall be provided for all demated connectors against physical damage and contamination. **[SSP 57000C, paragraph 3.12.4.3.8]**

6.4.4.3.9 Connector Shape

Payload connectors shall use different connector shapes, sizes or keying to prevent mating connectors when lines differ in content. **[SSP 57000C, paragraph 3.12.4.3.9]**

6.4.4.3.10 Fluid and Gas Line Connectors

Fluid and gas connectors that are mated and demated on-orbit shall be located and configured so that they can be fully inspected for leakage. **[SSP 57000C, paragraph 3.12.4.3.10]**

6.4.4.3.11 Alignment Marks or Guide Pins

A. Mating parts shall have alignment marks in a visible location during mating or guide pins (or their equivalent). **[SSP 57000C, paragraph 3.12.4.3.11.A]**

B. Deleted.

6.4.4.3.12 Coding

A. Both halves of mating connectors shall display a code or identifier which is unique to that connection. **[SSP 57000C, paragraph 3.12.4.3.12.A]**

B. The labels or codes on connectors shall be located so they are visible when connected or disconnected. **[SSP 57000C, paragraph 3.12.4.3.12.B]**

6.4.4.3.13 Pin Identification

Each pin shall be uniquely identifiable in each electrical plug and each electrical receptacle. At least every 10th pin must be labeled. **[SSP 57000C, paragraph 3.12.4.3.13]**

6.4.4.3.14 Orientation

Grouped plugs and receptacles shall be oriented so that the aligning pins or equivalent devices are in the same relative position. **[SSP 57000C, paragraph 3.12.4.3.14]**

6.4.4.3.15 Hose/Cable Restraints

A. Payloads shall provide a means to restrain the loose ends of hoses and cables. **[SSP 57000C, paragraph 3.12.4.3.15.A]**

B. Conductors, bundles, or cables shall be secured by means of clamps unless they are contained in wiring ducts or cable retractors. **[SSP 57000C, paragraph 3.12.4.3.15.B]**

C. Cables should be bundled if multiple cables are running in the same direction and the bundling does not cause EMI.

D. Loose cables (longer than 0.33 meters (1 foot) shall be restrained as follows**[SSP 57000C, paragraph 3.12.4.3.15.D]**:

Length (m)	Restraint Pattern (% of length) tolerances +/– 10%)
0.33–1.00	50
1.00–2.00	33,67
2.00–3.00	20, 40, 60, 80
>3.00	at least each 0.5 meters

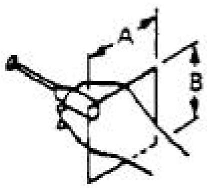
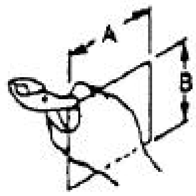
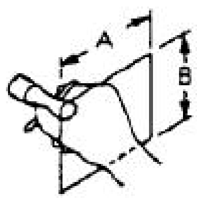
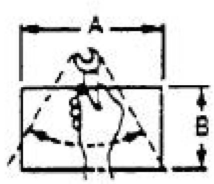
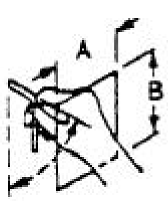
6.4.4.4 Fasteners

6.4.4.4.1 Non-Threaded Fasteners Status Indication

An indication of correct engagement (hooking, latch fastening, or proper positioning of interfacing parts) of non-threaded fasteners shall be provided. **[SSP 57000C, paragraph 3.12.4.4.1]**

6.4.4.4.2 Mounting Bolt/Fastener Spacing

Clearance around fasteners to permit fastener hand threading (if necessary) shall be a minimum of 0.5 inches for the entire circumference of the bolt head and a minimum of 1.5 inches over 180 degrees of the bolt head and provide the tool handle sweep as seen in Figure 6.4.4.4.2–1. Excepted are NSTS standard middeck lockers or payload–provided hardware with the static envelope dimensions (cross–section) as specified in Figures 3.4.2.1–1, 3.4.2.2–1 and 3.4.2.3–1 of NSTS–21000–IDD–MDK and other similar captive fastener arrangements. **[SSP 57000C, paragraph 3.12.4.4.2]**

Opening dimensions		Task
	A 117 mm (4.6 in) B 107 mm (4.2 in)	Using common screwdriver with freedom to turn hand through 180°
	A 133 mm (5.2 in) B 115 mm (4.5 in)	Using pliers and similar tools
	A 155 mm (6.1 in) B 135 mm (5.3 in)	Using T-handle wrench with freedom to turn wrench through 180°
	A 203 mm (8.0 in) B 135 mm (5.3 in)	Using open-end wrench with freedom to turn wrench through 62°
	A 122 mm (4.8 in) B 155 mm (6. in)	Using Allen-type wrench with freedom to turn wrench through 62°

[SSP 57000C, FIGURE 3.12.4.4.2–2]

Figure 6.4.4.4.2–1. Minimal Clearance for Tool–Operated Fasteners

6.4.4.4.3 Multiple Fasteners

When several fasteners are used on one item they shall be of identical type. **[SSP 57000C, paragraph 3.12.4.4.4]**

Note: Phillips or Torque-Set fasteners may be used where fastener installation is permanent relative to planned on-orbit operations or maintenance, or where tool-fastener interface failure can be corrected by replacement of the unit containing the affected fastener with a spare unit.

6.4.4.4.4 Captive Fasteners

All fasteners planned to be installed and/or removed on-orbit shall be captive when disengaged. **[SSP 57000C, paragraph 3.12.4.4.5]**

6.4.4.4.5 Quick Release Fasteners

A. Quick release fasteners shall require a maximum of one complete turn to operate (quarter – turn fasteners are preferred). **[SSP 57000C, paragraph 3.12.4.4.6.A]**

B. Quick release fasteners shall be positive locking in open and closed positions. **[SSP 57000C, paragraph 3.12.4.4.6.B]**

6.4.4.4.6 Threaded Fasteners

Only right handed threads shall be used. **[SSP 57000C, paragraph 3.12.4.4.7]**

6.4.4.4.7 Over Center Latches

A. Nonself-latching – Over center latches shall include a provision to prevent undesired latch element realignment, interface, or reengagement. **[SSP 57000C, paragraph 3.12.4.4.8.A]**

B. Latch lock – Latch catches shall have locking features. **[SSP 57000C, paragraph 3.12.4.4.8.B]**

C. Latch handles – If the latch has a handle, the latch handle and latch release shall be operable by one hand. **[SSP 57000C, paragraph 3.12.4.4.8.C]**

6.4.4.4.8 Winghead Fasteners

Winghead fasteners shall fold down and be retained flush with surfaces. **[SSP 57000C, paragraph 3.12.4.4.9]**

6.4.4.4.9 Fastener Head Type

A. Hex type external or internal grip or combination head fasteners shall be used where on-orbit crew actuation is planned, e.g., ORU replacement. **[SSP 57000C, paragraph 3.12.4.4.11.A]**

B. If a smooth surface is required, flush or oval head internal hex grip fasteners shall be used for fastening. **[SSP 57000C, paragraph 3.12.4.4.11.B]**

C. Slotted fasteners shall not be used to carry launch loads for hard-mounted equipment. Slotted fasteners are allowed in non-structural applications (e.g., computer data connectors, stowed commercial equipment). **[SSP 57000C, paragraph 3.12.4.4.11.C]**

6.4.4.4.10 One-Handed Actuation

Fasteners planned to be removed or installed on-orbit shall be designed and placed so they can be mated/demated using either hand. **[SSP 57000C, paragraph 3.12.4.4.12]**

6.4.4.4.11 Accessibility

IVA fasteners shall be separated to provide hand and tool clearance in accordance with Figure 6.4.4.4.2–1. **[SSP 57000C, paragraph 3.12.4.4.13]**

6.4.4.4.12 Access Holes

Covers or shields through which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment (and hand or necessary tool if either is required to replace). **[SSP 57000C, paragraph 3.12.4.4.14]**

6.4.5 Controls and Displays

6.4.5.1 Controls Spacing Design Requirements

All spacing between controls and adjacent obstructions shall meet the minimum requirements as shown in Figure 6.4.5.1–1, Control Spacing Requirements for Ungloved Operation. **[SSP 57000C, paragraph 3.12.5.1]**

6.4.5.2 Accidental Actuation

Requirements for reducing accidental actuation of controls are defined as follows:

6.4.5.2.1 Protective Methods

Payloads shall provide protection against accidental control actuation using one or more of the protective methods listed in sub–paragraphs A through G below. Infrequently used controls (i.e. those used for calibration) should be separated from frequently used controls. Leverlock switches or switch covers are strongly recommended for switches related to mission success. Switch guards may not be sufficient to prevent accidental actuation. [SSP 57000C, paragraph 3.12.5.2.1]

A. Locate and orient the controls so that the operator is not likely to strike or move them accidentally in the normal sequence of control movements. **[SSP 57000C, paragraph 3.12.5.2.1.A]**

B. Recess, shield, or otherwise surround the controls by physical barriers. The control shall be entirely contained within the envelope described by the recess or barrier. **[SSP 57000C, paragraph 3.12.5.2.1.B]**

C. Cover or guard the controls. Safety or lock wire shall not be used. **[SSP 57000C, paragraph 3.12.5.2.1.C]**

D. Cover guards when open shall not cover or obscure the protected control or adjacent controls. **[SSP 57000C, paragraph 3.12.5.2.1.D]**

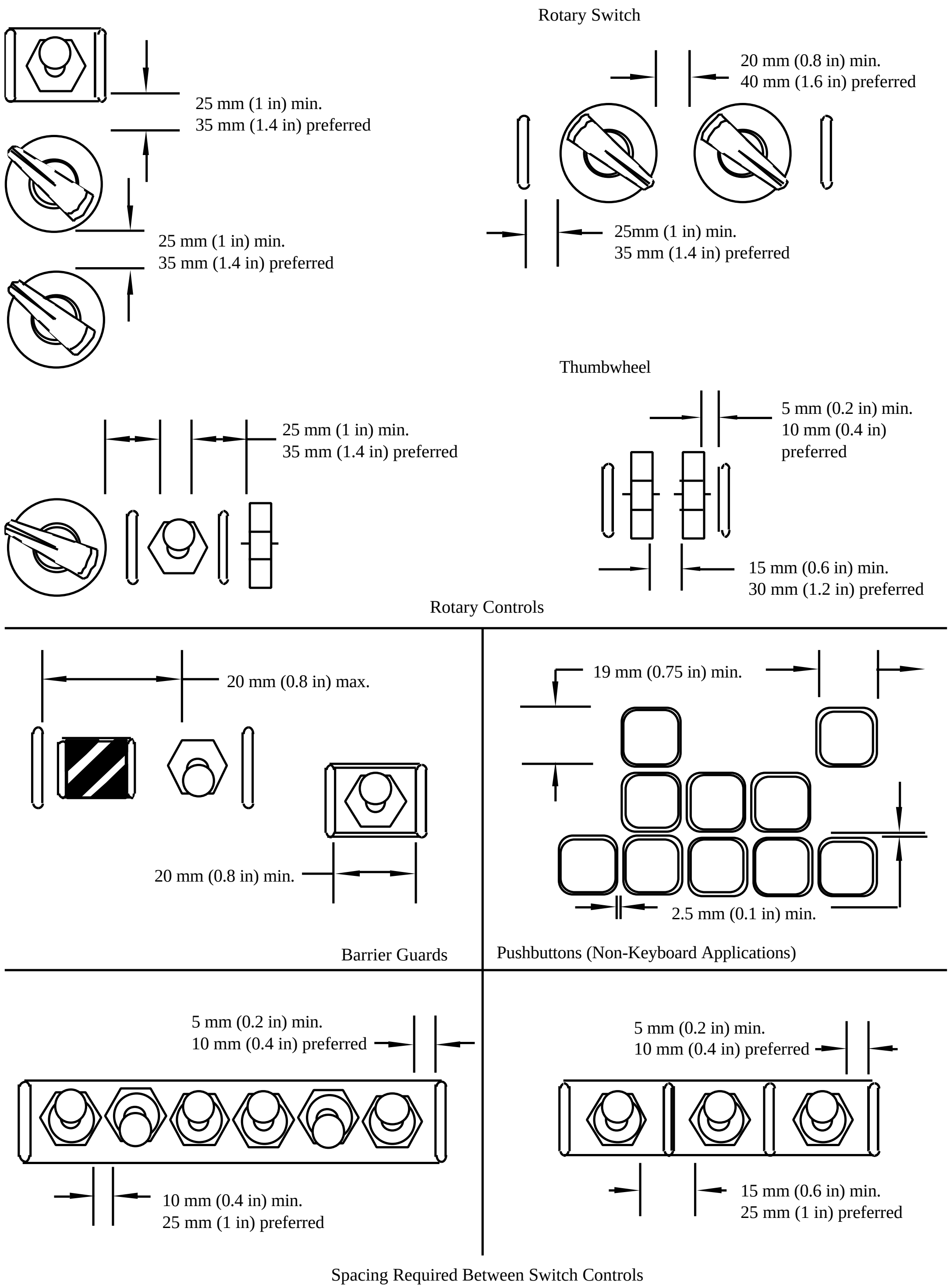
E. Provide the controls with interlocks so that extra movement (e.g., lifting switch out of a locked detent position) or the prior operation of a related or locking control is required. **[SSP 57000C, paragraph 3.12.5.2.1.E]**

F. Provide the controls with resistance (i.e., viscous or coulomb friction, spring-loading, or inertia) so that definite or sustained effort is required for actuation. **[SSP 57000C, paragraph 3.12.5.2.1.F]**

G. Provide the controls with a lock to prevent the control from passing through a position without delay when strict sequential actuation is necessary (i.e., the control moved only to the next position, then delayed). **[SSP 57000C, paragraph 3.12.5.2.1.G]**

6.4.5.2.2 Noninterference

Payload provided protective devices shall not cover or obscure other displays or controls. **[SSP 57000C, paragraph 3.12.5.2.2]**



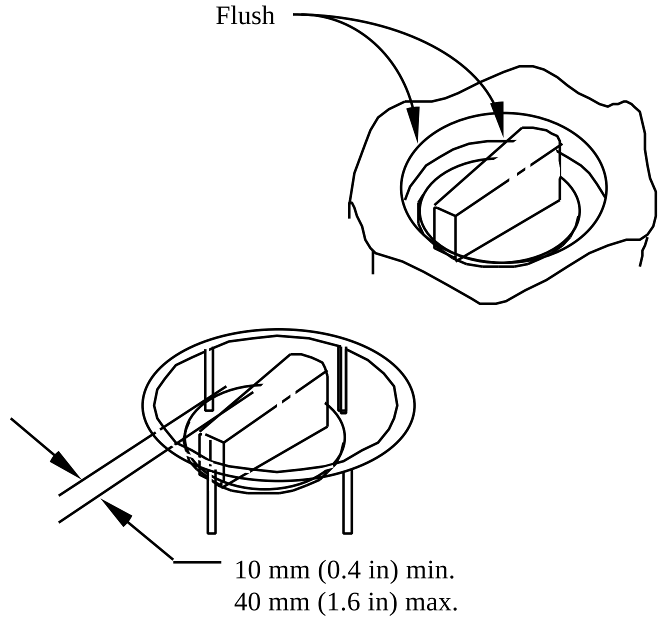
[SSP 57000C, FIGURE 3.12.5.1–1]

Figure 6.4.5.1–1. Control Spacing Requirements for Ungloved Operation

Note: Displays and controls used only for maintenance and adjustments, which could disrupt normal operations if activated, should be protected during normal operations, e.g., by being located separately or guarded/covered.

6.4.5.2.3 Dead-Man Controls

Dead-man controls are covered under NSTS 1700.7B, ISS Addendum paragraphs 200.4a and 303.2.



[SSP 57000C, FIGURE 3.12.5.2.3–1]

Figure 6.4.5.2.3–1. Rotary Switch Guard

6.4.5.2.4 Barrier Guards

Barrier guard spacing shall adhere to the requirements for use with the toggle switches, rotary switches, and thumbwheels as shown in Figures 6.4.5.1–1, Control Spacing Requirements for Ungloved Operation and 6.4.5.2.3–1, Rotary Switch Guard. **[SSP 57000C, paragraph 3.12.5.2.4]**

6.4.5.2.5 Recessed Switch Protection

When a barrier guard is not used, rotary switches that control critical functions shall be recessed as shown in Figure 6.4.5.2.3–1, Rotary Switch Guard. **[SSP 57000C, paragraph 3.12.5.2.5]**

6.4.5.2.6 Deleted

6.4.5.2.7 Position Indication

When payload switch protective covers are used, control position shall be evident without requiring cover removal. **[SSP 57000C, paragraph 3.12.5.2.7]**

6.4.5.2.8 Hidden Controls

Controls that cannot be directly viewed will be avoided. If present, hidden controls shall be guarded to protect against inadvertent actuation. **[SSP 57000C, paragraph 3.12.5.2.8]**

6.4.5.2.9 Hand Controllers

Hand controllers, excluding trackballs and mice, shall have a separate on/off control to prevent inadvertent actuation when the controller is not in use. **[SSP 57000C, paragraph 3.12.5.2.9]**

6.4.5.3 Valve Controls

Requirements for design of payload valve controls are defined as follows:

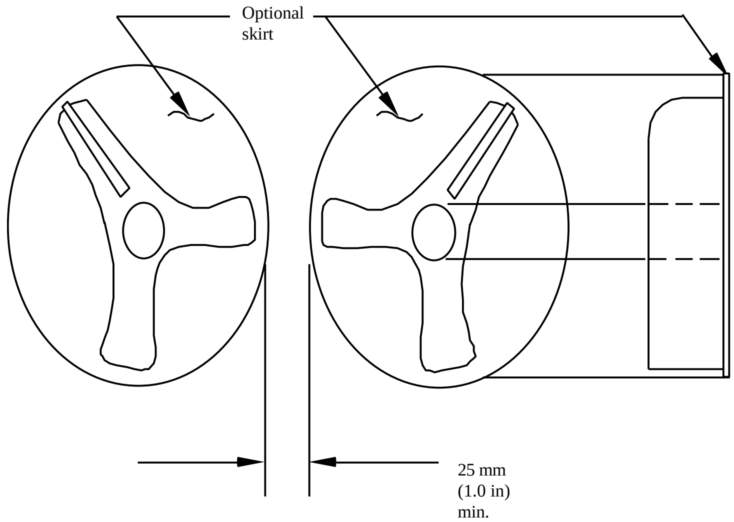
A. Low-Torque Valves – Valves requiring 1 N–m (10 in–lb) or less for operation are classified as “low-torque” valves and shall be provided with a “central pivot” type handle, 5.5 cm (2.25 in) or less in diameter. (see 6.4.5.3 D) **[SSP 57000C, paragraph 3.12.5.3.A]**

B. Intermediate-Torque Valves – Valves requiring between 1 and 2 N–m (10 and 20 in–lb) for operation are classified as “intermediate torque” valves and shall be provided with a “central pivot” type handle, 5.5 cm (2.25 in) or greater in diameter, or a “lever (end pivot type” handle, 7.5 cm (3 in) or greater in length. **[SSP 57000C, paragraph 3.12.5.3.B]**

C. High-Torque Valves – Valves requiring 2 N–m (20 in–lb) or more for operation are classified as “high-torque” valves and shall be provided “lever type” handles greater than 7.5 cm (3 in) or greater in length. **[SSP 57000C, paragraph 3.12.5.3.C]**

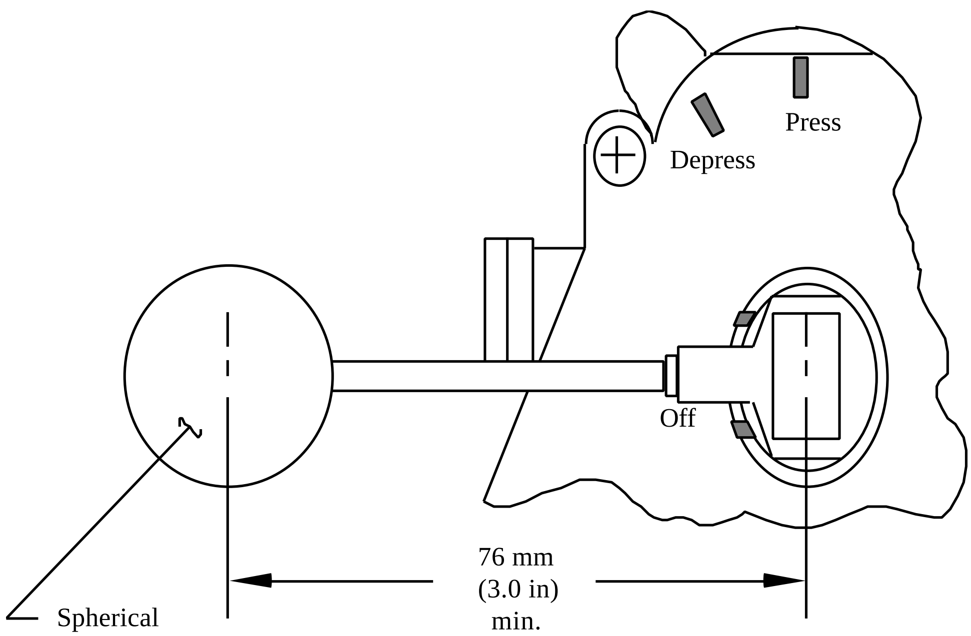
D. Handle Dimensions – Valve handles shall adhere to the clearances and dimensions illustrated in Figures 6.4.5.3–1, Valve Handle-Central Pivot Type and 6.4.5.3–2, Valve Handle-Lever Type. **[SSP 57000C, paragraph 3.12.5.3.D]**

E. Rotary Valve Controls – Rotary valve controls shall open the valve with a counter-clockwise motion. **[SSP 57000C, paragraph 3.12.5.3.E]**



[SSP 57000C, FIGURE 3.12.5.3–1]

Figure 6.4.5.3–1. Valve Handle - Central Pivot Type



[SSP 57000C, FIGURE 3.12.5.3–2]

Figure 6.4.5.3–2. Valve Handle – Lever Type

6.4.5.4 Toggle Switches

Dimensions for a standard toggle switch shall conform to the values presented in Figure 6.4.5.4–1, Toggle Switches. **[SSP 57000C, paragraph 3.12.5.4]**

	Dimensions		Resistance	
	L Arm Length	D Control Tip	Small Switch	Large Switch
Minimum	13 mm (1/2 in.)	3 mm (1/8 in.)	2.8 N (10 oz)	2.8 N (10 oz.)
Maximum	50 mm (2 in.)	25 mm (1 in.)	4.5 N (16 oz.)	11 N (40 oz.)

	Displacement between positions	
	2 position	3 position
Minimum	30°	17°
Maximum	80°	40°
Desired		25°

	Separation			
	Single finger operation	T	S Single finger sequential operation	Simultaneous operation by different fingers
Minimum	19 mm (3/4 in.)	25 mm (1 in.)	13 mm (1/2 in.)	16 mm (5.8 in.)
Optimum	50 mm (2 in.)	50 mm (2 in.)	25 mm (1 in.)	

T Using a lever lock toggle switch

[SSP 57000C, FIGURE 3.12.5.4–1]

Figure 6.4.5.4–1. Toggle Switches

6.4.6 Restraints and Mobility Aids

Payloads shall be designed such that all installation, operation, and maintenance can be performed using standard crew restraints, mobility aids, and interfaces as defined in SSP 30257:004. **[SSP 57000C, paragraph 3.12.6]**

6.4.6.1 Stowage Drawer Contents Restraints

A. Payload drawer/tray contents shall be restrained in such a way that the items do not float when the drawer/tray is opened or closed. **[SSP 57000C, paragraph 3.12.6.1.A]**

B. Payload drawer/tray contents shall be restrained in a way such that the items do not jam the drawer when the drawer is opened or closed. **[SSP 57000C, paragraph 3.12.6.1.B]**

C. Drawer/tray contents shall be restrained in such a way that the contents can be removed/replaced without using a tool. **[SSP 57000C, paragraph 3.12.6.1.C]**

6.4.6.2 Stowage and Equipment Drawers/Trays

A. All latches, handles, and operating mechanisms shall be designed to be latched/unlatched and opened/closed with one hand by the 95th percentile American male to the 5th percentile female. **[SSP 57000C, paragraph 3.12.6.2.A]**

B. The design of latches shall be such that their status (locked/unlocked) can be determined through visual inspection. **[SSP 57000C, paragraph 3.12.6.2.B]**

6.4.6.3 Captive Parts

Payloads and payload equipment shall be designed in such a manner to ensure that all unrestrained parts (e.g., locking pins, knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive. **[SSP 57000C, paragraph 3.12.6.3]**

6.4.6.4 Handle and Grasp Area Design Requirements

6.4.6.4.1 Handles and Restraints

All removable or portable items which cannot be grasped with one hand, as per Table 6.4.6.4.2–1 [TBD, referenced table is not included in SSP 57000], shall be provided with handles or other suitable means of grasping, tethering, carrying and restraining. **[SSP 57000C, paragraph 3.12.6.4.1]**

6.4.6.4.2 Handle Location/Front Access

Handles and grasp areas shall be placed on the accessible surface of a payload item consistent with the removal direction. **[SSP 57000C, paragraph 3.12.6.4.3]**

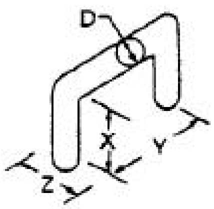
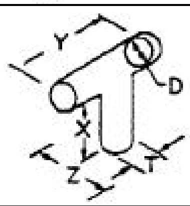
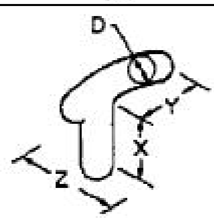
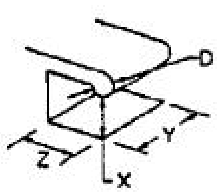
6.4.6.4.3 Handle Dimensions

IVA handles for movable or portable units shall be designed in accordance with the minimum applicable dimensions in Figure 6.4.6.4.3–1. **[SSP 57000C, paragraph 3.12.6.4.4]**

6.4.6.4.4 Non-Fixed Handles Design Requirements

Hinged, foldout, or attachable (i.e., non-fixed) handles will comply with the following:

A. Nonfixed handles shall have a stop position for holding the handle perpendicular to the surface on which it is mounted. **[SSP 57000C, paragraph 3.12.6.4.5.A]**

Illustration	Type of handle	Dimensions in mm (in inches) (Bare hand)		
		X	Y	Z
	Two-finger bar One-hand bar Two-hand bar	32 (1-1/4) 48 (1-7/8) 48 (1-7/8)	65 (2-1/2) 111 (4-3/8) 215 (8-1/2)	75 (3) 75 (3) 75 (3)
	T-bar	38 (1-1/2)	100 (4)	75 (3)
	J-bar	50 (2)	100 (4)	75 (3)
	Two-finger recess One-hand recess	32 (1-1/4) 50 (2)	65 (2-1/2) 110 (4-1/4)	75 (3) 90 (3-1/2)
	Finger-tip recess On-finger recess	19 (3/4) 32 (1-1/4)	— —	13 (1/2) 50 (2)
Curvature of handle or edge (DOES NOT PRECLUDE USE OF OVAL HANDLES)	Weight of item up to 6.8 kg (up to 15 lbs) 6.8 to 9.0 kg (15 to 20 lbs) 9.0 to 18 kg (20 to 40 lbs) Over 18 kg (over 40 lbs) T-bar post	Minimum Diameter D = 6 mm (1/4 in) D = 13 mm (1/2 in) D = 19 mm (3/4 in) D = 25 mm (1 in) T = 13 mm (1/2 in)	Gripping efficiency is best if finger can curl around handle or edge to any angle of 2/3 Õ rad (120°) or more	

[SSP 57000C, FIGURE 3.12.6.4.4–1]

Figure 6.4.6.4.3–1. Minimum IVA Handle Dimensions for IVA Applications

B. Nonfixed handles shall be capable of being placed in the use position by one hand and shall be capable of being removed or stowed with one hand. **[SSP 57000C, paragraph 3.12.6.4.5.B]**

C. Attachable/removable handles shall incorporate tactile and/or visual indication of locked/unlocked status. **[SSP 57000C, paragraph 3.12.6.4.5.C]**

6.4.7 Identification Labeling

Integrated racks, all (installed in the rack or separately) sub–rack elements, loose equipment, stowage trays, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form (including IMS bar codes) such as decals and placards, which can be adhered, “silk screened”, engraved, or otherwise applied directly onto the hardware. Appendix C [of SSP 57000] provides instructions for label and decal design and approval. **[SSP 57000C, paragraph 3.12.7]**

6.4.8 Color

See paragraph 6.4.3.5.

6.4.9 Crew Safety

6.4.9.1 Electrical Hazards

Electrical equipment other than bioinstrumentation equipment will incorporate the following controls as specified below:

A. If the exposure condition is below the threshold for shock (i.e., below maximum leakage current and voltage requirements as defined within this section), no controls are required. Non–patient equipment with internal voltages not exceeding 30 volts rms or DC nominal (32 volts rms or DC maximum) will contain potentials below the threshold for electrical shock. **[SSP 57000C, paragraph 3.12.9.1.A]**

B. If the exposure condition exceeds the threshold for shock, but is below the threshold of the let-go current profile (critical hazard) as defined in Table 6.4.9.1–1, two independent controls (e.g., a safety (green) wire, bonding, insulation, leakage current levels below maximum requirements) shall be provided such that no single failure, event, or environment can eliminate more than one control. **[SSP 57000C, paragraph 3.12.9.1.B]**

C. If the exposure condition exceeds both the threshold for shock and the threshold of the let-go current profile (catastrophic hazardous events) as defined in Table 6.4.9.1–1, three independent controls shall be provided such that no combination of two failures, events or environments can eliminate more than two controls. **[SSP 57000C, paragraph 3.12.9.1.C]**

TABLE 6.4.9.1–1. LET-GO CURRENT PROFILE, THRESHOLD VERSUS FREQUENCY

FREQUENCY	MAXIMUM TOTAL PEAK CURRENT (AC + DC COMPONENTS COMBINED) MILLIAMPERES
DC	40.0
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
>10000	24.3

[SSP 57000C, TABLE 3.12.9.1–1]

D. If two dependent controls are provided, the physiological effect that a crew member experiences as a result of the combinations of the highest internal voltage applied to or generated within the equipment and the frequency and wave form associated with a worst case credible failure shall be below the threshold of the let-go current profile as defined in Table 6.4.9.1–1. **[SSP 57000C, paragraph 3.12.9.1.D]**

E. If it cannot be demonstrated that the hazard meets the conditions of paragraph A, B, or C above, three independent hazard controls shall be provided such that no combination of two failures, events or environments can eliminate more than two controls. **[SSP 57000C, paragraph 3.12.9.1.E]**

6.4.9.1.1 Mismatched

A. The design of electrical connectors shall make it impossible to inadvertently reverse a connection or mate the wrong connectors if a hazardous condition can be created. **[SSP 57000C, paragraph 3.12.9.1.1]**

B. Payload and on-orbit support equipment, wire harnesses, and connectors shall be designed such that no blind connections or disconnections must be made during payload installation, operation, removal, or maintenance on orbit unless the design includes scoop proof connectors or other protective features (NSTS 1700.7B, ISS Addendum, paragraph 221). **[SSP 57000C, paragraph 3.12.9.1.1]**

C. For payload equipment, for which mismating or cross-connection may damage ISS-provided equipment, plugs, and receptacles (connectors), shall be selected and applied such that they cannot be mismatched or cross-connected in the intended system as well as adjacent systems. Although identification markings or labels are required, the use of identification alone is not sufficient to preclude mismating. **[SSP 57000C, paragraph 3.12.9.1.1]**

D. For all other payload connections, combinations of identification, keying and clocking, and equipment test and checkout procedures shall be employed at the payload's discretion to minimize equipment risk while maximizing on-orbit operability. **[SSP 57000C, paragraph 3.12.9.1.1]**

6.4.9.1.2 Overload Protection

6.4.9.1.2.1 Device Accessibility

An overload protective device shall not be accessible without opening a door or cover, except that an operating handle or operating button of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure. **[SSP 57000C, paragraph 3.12.9.1.4.1]**

6.4.9.1.2.2 Extractor –Type Fuse Holder

The design of the extractor-type fuse holder shall be such that the fuse is extracted when the cap is removed. **[SSP 57000C, paragraph 3.12.9.1.4.2]**

6.4.9.1.2.3 Overload Protection Location

Overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on-orbit shall be located where they can be seen and replaced or reset without removing other components. **[SSP 57000C, paragraph 3.12.9.1.4.3]**

6.4.9.1.2.4 Overload Protection Identification

Each overload protector (fuse or circuit breaker) intended to be manually replaced or physically reset on-orbit shall be readily identified or keyed for its proper value. **[SSP 57000C, paragraph 3.12.9.1.4.4]**

6.4.9.1.2.5 Automatic Restart Protection

Controls shall be employed that prevent automatic restarting after an overload-initiated shutdown. **[SSP 57000C, paragraph 3.12.9.1.4.5]**

6.4.9.2 Sharp Edges and Corners Protection

Payload design within a pressurized module shall protect crewmembers from sharp edges and corners during all crew operations in accordance with SSP 50005 paragraph 6.3.3. **[SSP 57000C, paragraph 3.12.9.2]**

6.4.9.3 Holes

Holes that are round or slotted in the range of 10.0 to 25.0 mm (0.4 to 1.0 in.) shall be covered. **[SSP 57000C, paragraph 3.12.9.3]**

6.4.9.4 Latches

Latches that pivot, retract, or flex so that a gap of less than 35 mm (1.4) exists shall be designed to prevent entrapment of a crewmember's appendage. **[SSP 57000C, paragraph 3.12.9.4]**

6.4.9.5 Screws and Bolts

Threaded ends of screws and bolts accessible by the crew and extending more than 3.0 mm (0.12 in) shall be capped to protect against sharp threads. **[SSP 57000C, paragraph 3.12.9.5]**

6.4.9.6 Securing Pins

Securing pins shall be designed to prevent their inadvertently backing out above the handhold surface. **[SSP 57000C, paragraph 3.12.9.6]**

6.4.9.7 Levers, Cranks, Hooks, and Controls

Levers, cranks, hooks, and controls shall not be located where they can pinch, snag, or cut the crewmembers or their clothing. **[SSP 57000C, paragraph 3.12.9.7]**

6.4.9.8 Burrs

Exposed surfaces shall be free of burrs. **[SSP 57000C, paragraph 3.12.9.8]**

6.4.9.9 Locking Wires

A. Safety wires shall not be used on fasteners which must be unfastened for on-orbit removal or replacement. **[SSP 57000C, paragraph 3.12.9.9.A]**

B. All fracture-critical fasteners as defined in SSP 52005 (paragraph 5.6, Fastener Requirements, and Appendix B, Glossary of Terms), which must be unfastened for on-orbit removal or replacement shall be safety cabled or cotter pinned. **[SSP 57000C, paragraph 3.12.9.9.B]**

6.4.9.10 Audio Devices (Displays)

A. The design of audio devices (displays) and circuits shall protect against false alarms. **[SSP 57000C, paragraph 3.12.9.10.A]**

B. Deleted.

C. All audio device (displays) shall be equipped with circuit test devices or other means of operability testing. **[SSP 57000C, paragraph 3.12.9.10.C]**

D. An interlocked, manual disable shall be provided if there is any failure mode which can result in a sustained activation of an audio device (display). **[SSP 57000C, paragraph 3.12.9.10.D]**

6.4.9.11 Egress

All payload egress requirements shall be in accordance with NSTS 1700.7B, ISS Addendum, paragraph 205. **[SSP 57000C, paragraph 3.12.9.12]**

6.4.10 Payload In-Flight Maintenance

Payloads shall be designed to be maintainable using Space Station provided on-board tools. A list of available tools on-orbit are defined in the Payload Accommodations Handbook. **[SSP 57000C, paragraph 3.12.10]**

7.0 SAFETY, RELIABILITY, MAINTAINABILITY, AND QUALITY ASSURANCE (SR&QA)

7.1 SAFETY

The processes, responsibilities, and schedules for the development of flight safety data packages are specified in LS-71002, HRF System Safety Plan.

7.1.1 Payload Safety Requirements

HRF payloads shall be designed to meet the requirements of NSTS 1700.7 and NSTS 1700.7B ISS Addendum, KHB 1700.7, and NSTS/ISS 18798.

7.1.2 Safety Documentation

Safety documentation shall be prepared in accordance with the data submittal requirements in NSTS/ISS 13830.

7.2 RELIABILITY AND MAINTAINABILITY

Reliability and maintainability requirements for HRF integrated rack hardware shall be as defined in LS-71026, Human Research Facility (HRF) Reliability Plan For The HRF Integrated Rack.

7.2.1 Useful Life

See paragraph 3.1.

7.3 QUALITY ASSURANCE

7.3.1 HRF Quality Plan

Quality Assurance for the HRF Program shall be implemented in accordance with the LS-71030, Quality Assurance Plan for the Human Research Facility.

7.3.2 Non-Conformance Reporting

1. For flight hardware procured under a NASA contract or subcontract at a site other than JSC, non-conformance reporting requirements shall be specified in the Statement of Work (SOW) Data Requirement List (DRL) and Data Requirements Documents (DRDs) shall be used to identify the submittal and data requirements.

2. For flight hardware developed at JSC, non-conformance reporting shall be in accordance with JPD 5335.1 and the applicable technical division plan and addressed in the end item acceptance and certification plan.

3. Non-conformances which meet the Level 1 Problem Reporting And Corrective Action (PRACA) criteria for payloads as defined in SSP 30223, shall be reported in accordance with SSP 30223.

4. Software non-conformance reporting shall be in accordance with LS-71020-1, Software Configuration Management Plan and Procedure for the Human Research Facility.

7.3.3 Acceptance Data Package (ADP)

An ADP shall be provided for all flight end items.

1. The SOW for procured flight items shall contain a DRD specifying ADP contents using SSP 30695, Acceptance Data Package Requirements Specification as a guideline.

2. Contents of the ADP for flight end items developed at JSC shall be documented in end item development plans using SSP 30695, Acceptance Data Package Requirements Specification as a guideline.

8.0 QUANTITIES AND SCHEDULES

End item quantities and delivery schedules shall be as specified in task orders and SOW.

9.0 PREPARATION FOR SHIPMENT

9.1 GENERAL

A. The methods of preservation, packaging, and packing used for shipment, together with necessary special control during transportation, shall adequately protect the article(s) from damage or degradation in reliability or performance as a result of the natural and induced environments encountered during transportation and subsequent indoor storage.

B. To reduce program cost, prior to developing a newly designed container, every effort will be made by project participants to use container designs and/or containers available commercially or from Government inventories. If reusable containers are not available, a screening process should be initiated for container availability in the following priority: existing containers, commercial off-the-shelf containers, and modified commercial off-the shelf containers. Shipping containers and protective devices will be designed for effective and economical manufacture, procurement, and transportability.

9.2 PACKING, HANDLING, AND TRANSPORTATION

A. Packaging, handling, and transportation shall be in accordance with applicable requirements of NHB 6000.1C, and referenced documents therein.

B. The HRF Rack shall be compatible with the PG-3 designed rack handling adapter and shipping container such that the rack will not be damaged or moved out of alignment during shipment.

C. Documented procedures and physical controls shall be established to ensure that the HRF rack and individual items of equipment will not be subjected to temperature, shock, and humidity outside the non-operational limits during shipment.

D. The HRF rack shall be cleaned to the “Visibly Clean Level 1 (Sensitive)” as determined in JSC-SN-C-0005, Specification Contamination Control Requirements for the Shuttle Program.

9.3 PRESERVATION AND PACKING

Preservation and packing shall be in accordance with approved Packaging, Handling, and Transportation Records (PHTRs)

9.4 MARKING FOR SHIPMENT

Interior and exterior containers shall be marked and labeled in accordance with NHB 6000.1C including precautionary markings necessary to ensure safety of personnel and facilities, and to ensure safe handling, transport, and storage. Should the HRF rack and individual items of equipment contain any hazard materials, markings shall also comply with applicable requirements governing packaging and labeling of hazard materials. Packages with reuse capability shall be identified with the words “Reusable Container - Do Not Destroy - Retain for Reuse.” NASA Critical Item Labels (Form 1368 series) shall be applied in accordance with NHB 6000.1C.

9.5 NASA CRITICAL SPACE ITEM LABEL

A. The NASA Critical Space Item Labels Form 1368 to exterior and interior shipping containers in accordance with NHB 6000.1C.

B. Integration/Transport to ISS

HRF ORUs will be launched and returned in a pressurized carrier such as the MPLM, the orbiter middeck or any international transfer vehicle such as the Progress, Automated Transfer Vehicle (ATV), or other transfer vehicles. They will be integrated into SIR drawers, middeck/EXPRESS lockers, or Resupply Stowage Rack (RSR) trays. Large items may require soft stowage accommodations such as the Resupply Stowage Platform (RSP) or the Aisle Stowage Container (ASC). Biological samples will require cold stowage in a freezer.

Analytical and physical integration of HRF ORUs will be performed by the ISS Cargo Integration (CI) organization. CI has the tools and expertise necessary to perform drawer/tray/rack layout, etc. CI will also perform the actual physical integration of HRF stowage items in preparation for launch. Science samples that require late stowage may be integrated by the Utilization organization at KSC. HRF will provide to CI all necessary data to perform these tasks such as engineering drawings of individual stowage items, weight, dimensions, hardware configuration, etc. Detailed process description and data requirements will be documented in Station Program Implementation Plan (SPIP) Volumes 3, 4, and the PIA.

APPENDIX A
GENERIC DATA REQUIREMENTS LIST (DRL) FOR THE HRF PROGRAM

This list provides a generic set of documentation products required by the HRF Program. Required documentation products for flight end items may vary depending on classification and criticality. Specific documentation products and development milestones will be defined in the end item development plan or SOW.

No.	TITLE	SRDR	PDR	CDR	SAR	PIRR	FRR	MSR
	PLANS & REQUIREMENTS							
1	Acceptance Plan		P	F				
2	Acoustics Control Plan		P	F				
3	Applicable Standards List	P	F					
4	Build-To Specification (Level C)		P	F				
5	Configuration Management Plan	P	F					
6	Cost and Schedule Report		P	F				
7	Electromagnetic Interference/Compatibility Plan		P	F				
8	Engineering Master Plan/Master Schedule	P	F					
9	Fracture Control Plan		P	F				
10	Fracture Control Summary Report			P	F			
11	Hardware Interface Control Document		P	C		F		
12	Listing of All Payload Rack Protrusions		P	F				
13	Interface Requirements		P	F				
14	Launch Site Safety Plan (* Per KHB 1700.7)				*	*	*	
15	Life Cycle Cost Estimates (at Project Proposal)							
16	Limited Life List		P	F				
17	Logistics Support Analysis		P	F				
18	Integrated Logistics Support Plan		P	F				
19	Preflight Imagery Plan		P	F				
20	Materials and Processes Control Plan		P	F				
21	Materials Usage Agreements		P	F				
22	Microgravity Control Plan		P	F				
23	Payload Integration Agreement		P	C		F		
24	Payload Integration Agreement Addendas		P	C		F		
25	Payload Integration Agreement Data Sets			P		F		
26	Project Management Plan	P	F					
27	Project Technical Requirements Specification		P	F				
28	Risk Management Plan		F					
29	Security Plan		P	F				
30	Software Interface Control Document		P	C		F		
31	Specification Tree		P	F				
32	Technical Performance Measurement Plan		P	F				
33	Test Plans		P	F				
	Payload Unique Verification Plan		P	C		F		
34	Payload Verification Plan (PVP)		P	C		F		
35	PVP Waivers Submit					C		
36	Work Breakdown Structure (at Project Proposal)							
38	Command and Control Plan		P	F				
39	Ground Processing Plan		P	F				
40	Operations Plan		P	F				
41	Training Plan		P	F				
	Trainer Development Specification		P	F				
42	Reliability Report		P	F				
43	Technical Task Agreement (Per POP Cycle)							S

No.	TITLE	SRDR	PDR	CDR	SAR	PIRR	FRR	MSR
	PLANS & REQUIREMENTS							
44	Phase 1 Flight Safety Review (Ground/Flight)		C					
45	Phase 2 Flight Safety Review (Ground/Flight)			C				
46	Phase 3 Flight Safety Review (Ground/Flight)				C			
47	Acceptance Test Report				F			
48	Certification of Flight/Launch Readiness						F	
49	Design Analysis Reports (90%)		P	F				
50	Design Data Package (90%)		P	C				
51	Drawing Tree/Engineering Drawing List (90%)		P	C				
52	Electrical, Thermal, C&DH Drawings/Schematics (90%)		P	C				
53	FMEA (Failure Mode & Effects Analysis)		P	F				
54	Critical Items List		P	F				
55	Logistics Support Analysis Record		P	F				
56	Integrated Schematics	P		F				
57	On-Orbit Configuration Drawings (including definition of unique protrusions)		P	F				
58	Operations Procedures			P	F			
59	Parts List		P		F			
60	Qualification Test Report		P	F				
61	Risk Analysis				F			
62	Safety Analysis Report	P			F			
63	Technical Performance Measures Report		P	F				
64	Acceptance Data Package/IDP Supplement (Ref. SSP 30695, ADP, Ref. SSP 52000-PDS for IDP Supplement)			P	F	U	U	
65	Payload Development Schedule	P	C	U	U	U	U	S
66	Payload Integration Management Schedule	P	C	U	U	U	U	S

SRDR - System Requirements Definition Review
PDR - Preliminary Design Review
CDR - Critical Design Review
SAR - System Acceptance Review
PIRR - Payload Integration Readiness Review
FRR - Flight Readiness Review
MSR - Monthly Status Review

P - Preliminary

C - Completed
F - Final
U - Updated
S - Status

APPENDIX B

SECTION 6 REQUIREMENTS TRACEABILITY MATRIX

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
	6.0	HARDWARE INTERFACE AND DESIGNs REQUIREMENTS	
	6.0	HARDWARE INTERFACE AND DESIGNS REQUIREMENTS	
	6.1	HRF RACK INTERFACE AND DESIGN REQUIREMENTS	
	6.1.1	STRUCTURAL/MECHANICAL	
	6.1.1.1	GSE INTERFACES	
3.1.1.1.A	6.1.1.1.A	GSE INTERFACES	
3.1.1.1.B	6.1.1.1.B	GSE INTERFACES	
3.1.1.1.C	6.1.1.1.C	GSE INTERFACES	
3.1.1.1.D	6.1.1.1.D	GSE INTERFACES	
	6.1.1.2	MPLM INTERFACES	
3.1.1.2.A	6.1.1.2.A	MPLM INTERFACES	
3.1.1.2.B	6.1.1.2.B	MPLM INTERFACES	
3.1.1.2.E	6.1.1.2.C	MPLM INTERFACES	
	6.1.1.3	LOADS REQUIREMENTS	
3.1.1.3.A	6.1.1.3.A	LOADS REQUIREMENTS	
3.1.1.3.B	6.1.1.3.B	LOADS REQUIREMENTS	
3.1.1.3.C	6.1.1.3.C	LOADS REQUIREMENTS	
3.1.1.3.D	6.1.1.3.D	LOADS REQUIREMENTS	
3.1.1.3.E	6.1.1.3.E	LOADS REQUIREMENTS	
3.1.1.3.F	6.1.1.3.F	LOADS REQUIREMENTS	
	6.1.1.4	RACK REQUIREMENTS	
3.1.1.4.A	6.1.1.4.A	RACK REQUIREMENTS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.1.1.4.B	6.1.1.4.B	RACK REQUIREMENTS	
3.1.1.4.C	6.1.1.4.C	RACK REQUIREMENTS	
3.1.1.4.D	6.1.1.4.D	RACK REQUIREMENTS	
3.1.1.4.E	6.1.1.4.E	RACK REQUIREMENTS	
3.1.1.4.I	6.1.1.4.F	RACK REQUIREMENTS	
3.1.1.4.J	6.1.1.4.G	RACK REQUIREMENTS	
3.1.1.4.K	6.1.1.4.H	RACK REQUIREMENTS	
3.1.1.4.L	6.1.1.4.I	RACK REQUIREMENTS	
3.1.1.5.A	6.1.1.5	SAFETY CRITICAL STRUCTURES REQUIREMENTS	
	6.1.1.6	CONNECTOR AND UMBILICAL PHYSICAL MATE	
3.1.1.6.1	6.1.1.6.1	CONNECTOR PHYSICAL MATE	
3.1.1.6.2	6.1.1.6.2	UMBILICAL PHYSICAL MATE	
	6.1.1.7	MICROGRAVITY	
	6.1.2	ELECTRICAL INTERFACE REQUIREMENTS	
3.2.1.1.1	6.1.2.1	STEADY-STATE VOLTAGE CHARACTERISTICS	
	6.1.2.2	RIPPLE VOLTAGE CHARACTERISTICS	
3.2.1.2.1	6.1.2.2.1	RIPPLE VOLTAGE AND NOISE	
3.2.1.2.2	6.1.2.2.2	RIPPLE VOLTAGE SPECTRUM	
3.2.1.3.1	6.1.2.3	TRANSIENT VOLTAGES	
3.2.1.3.3	6.1.2.4	FAULT CLEARING AND PROTECTION	
	6.1.2.5	NON-NORMAL VOLTAGE RANGE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.1.3.4.A	6.1.2.5.A	NON-NORMAL VOLTAGE RANGE	
3.2.1.3.4.B	6.1.2.5.B	NON-NORMAL VOLTAGE RANGE	
	6.1.2.6	COMMON MODE NOISE	
3.2.1.4.A	6.1.2.6.A	COMMON MODE NOISE	
3.2.1.4.B	6.1.2.6.B	COMMON MODE NOISE	
	6.1.2.7	UIP CONNECTORS AND PIN ASSIGNMENTS	
3.2.2.1.A	6.1.2.7.A	UIP CONNECTORS AND PIN ASSIGNMENTS	
3.2.2.1.B	6.1.2.7.B	UIP CONNECTORS AND PIN ASSIGNMENTS	
3.2.2.1.C	6.1.2.7.C	UIP CONNECTORS AND PIN ASSIGNMENTS	
	6.1.2.8	POWER BUS ISOLATION	
3.2.2.2.A	6.1.2.8.A	POWER BUS ISOLATION	
3.2.2.2.B	6.1.2.8.B	POWER BUS ISOLATION	
3.2.2.3	6.1.2.9	COMPATIBILITY WITH SOFT START/STOP RPC	
3.2.2.4	6.1.2.10	SURGE CURRENT	
3.2.2.5	6.1.2.11	REVERSE ENERGY/CURRENT	
	6.1.2.12	REMOTE POWER CONTROLLERS (RPCs)	
3.2.2.6.1.1.A	6.1.2.12.A	REMOTE POWER CONTROLLERS (RPCs)	
3.2.2.6.1.1.D	6.1.2.12.B	REMOTE POWER CONTROLLERS (RPCs)	
3.2.2.6.1.1.E	6.1.2.12.C	REMOTE POWER CONTROLLERS (RPCs)	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.2.6.2.1.1	6.1.2.12.D	REMOTE POWER CONTROLLERS (RPCs)	
	6.1.2.13	RACK COMPLEX LOAD IMPEDANCES	
3.2.2.7.1.A	6.1.2.13.A	RACK COMPLEX LOAD IMPEDANCES	
3.2.2.7.1.B	6.1.2.13.B	RACK COMPLEX LOAD IMPEDANCES	
	6.1.2.14	LARGE SIGNAL STABILITY	
3.2.2.8.1	6.1.2.14.1	LARGE SIGNAL STABILITY	
3.2.2.8.2	6.1.2.14.2	LARGE SIGNAL STABILITY	
3.2.2.9	6.1.2.15	MAXIMUM RIPPLE VOLTAGE EMISSIONS	
3.2.2.10	6.1.2.16	ELECTRICAL LOAD-STAND ALONE STABILITY	
	6.1.2.17	WIRE DERATING	
3.2.3.1.B	6.1.2.17.A	WIRE DERATING	
3.2.3.1.C	6.1.2.17.B	WIRE DERATING	
	6.1.2.18	EXCLUSIVE POWER FEEDS	
3.2.3.2.A	6.1.2.18.A	EXCLUSIVE POWER FEEDS	
3.2.3.2.B	6.1.2.18.B	EXCLUSIVE POWER FEEDS	
3.2.3.3	6.1.2.19	LOSS OF POWER	
3.2.4	6.1.2.20	ELECTROMAGNETIC COMPATIBILITY	
3.2.4.1	6.1.2.20.1	ELECTRICAL GROUNDING	
3.2.4.2	6.1.2.20.2	ELECTRICAL BONDING	
3.2.4.3	6.1.2.20.3	CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS	
3.2.4.4	6.1.2.20.4	ELECTROMAGNETIC INTERFERENCE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.4.6	6.1.2.20.5	ALTERNATING CURRENT (AC) MAGNETIC FIELDS	
3.2.4.7	6.1.2.20.6	DIRECT CURRENT (DC) MAGNETIC FIELDS	
3.2.4.5	6.1.2.21	ELECTROSTATIC DISCHARGE	
3.2.4.8	6.1.2.22	CORONA	
3.2.4.9	6.1.2.23	LIGHTNING	
3.2.4.10	6.1.2.24	EMI SUSCEPTIBILITY FOR SAFETY-CRITICAL CIRCUITS	
	6.1.2.25	PAYLOAD ELECTRICAL SAFETY	
3.2.5.1.1	6.1.2.25.1	MATING/DEMATING OF POWERED CONNECTORS	
3.2.5.1.2]	6.1.2.25.2	SAFETY-CRITICAL CIRCUITS REDUNDANCY	
3.2.5.2	6.1.2.25.3	HRF RACK POWER REMOVAL SWITCH	
	6.1.2.25.4	POWER SWITCHES/CONTROLS	
3.2.5.3.A	6.1.2.25.4.A	POWER SWITCHES/CONTROLS	
3.2.5.3.B	6.1.2.25.4.B	POWER SWITCHES/CONTROLS	
3.2.5.3.C	6.1.2.25.4.C	POWER SWITCHES/CONTROLS	
	6.1.2.25.5	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.5.4.A	6.1.2.25.5.A	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.B	6.1.2.25.5.B	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.C	6.1.2.25.5.C	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.D	6.1.2.25.5.D	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.E	6.1.2.25.5.E	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.F	6.1.2.25.5.F	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.5.4.G	6.1.2.25.5.G	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
	6.1.3	COMMAND AND DATA HANDLING INTERFACE REQUIREMENTS	
	6.1.3.1	WORD/BYTE NOTATIONS, TYPES AND DATA TRANSMISSIONS	
3.3.2.1	6.1.3.1.1	WORD/BYTE NOTATIONS	
3.3.2.2	6.1.3.1.2	DATA TYPES	
	6.1.3.1.3	DATA TRANSMISSIONS	
3.3.2.3.A	6.1.3.1.3.A	DATA TRANSMISSIONS	
3.3.2.3.B	6.1.3.1.3.B	DATA TRANSMISSIONS	
3.3.2.3.C	6.1.3.1.3.C	DATA TRANSMISSIONS	
3.3.4	6.1.3.2	CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS	
3.3.4.1	6.1.3.2.1	CCSDS DATA	
3.3.4.1.1	6.1.3.2.1.1	CCSDS DATA PACKETS	
3.3.4.1.1.1	6.1.3.2.1.1.1	CCSDS PRIMARY HEADER	
3.3.4.1.1.2	6.1.3.2.1.1.2	CCSDS SECONDARY HEADER	
3.3.4.1.2	6.1.3.2.1.2	CCSDS DATA FIELD	
3.3.4.1.3	6.1.3.2.1.3	CCSDS DATA BITSTREAM	
3.3.4.1.4	6.1.3.2.1.4	CCSDS APPLICATION PROCESS IDENTIFICATION FIELD	
	6.1.3.2.2	CCSDS TIME CODES	
3.3.4.2.1	6.1.3.2.2.1	CCSDS UNSEGMENTED TIME	
3.3.4.2.2	6.1.3.2.2.2	CCSDS SEGMENTED TIME	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.3.5	6.1.3.3	MIL-STD-1553B LOW RATE DATA LINK (LRDL)	
	6.1.3.3.1	MIL-STD-1553B PROTOCOL	
3.3.5.1.1	6.1.3.3.1.1	STANDARD MESSAGES	
3.3.5.1.2	6.1.3.3.1.2	COMMANDING	
3.3.5.1.3	6.1.3.3.1.3	HEALTH AND STATUS DATA	
	6.1.3.3.1.4	SAFETY DATA	
3.3.5.1.4	6.1.3.3.1.4.A	SAFETY DATA	
3.3.5.1.4	6.1.3.3.1.4.B	SAFETY DATA	
	6.1.3.3.1.4.1	CAUTION AND WARNING	
	6.1.3.3.1.4.1.1	CLASS 1 – EMERGENCY	
3.3.5.1.4.1.2	6.1.3.3.1.4.1.2	CLASS 2 – WARNING	
3.3.5.1.4.1.3	6.1.3.3.1.4.1.3	CLASS 3 – CAUTION	
3.3.5.1.4.1.4	6.1.3.3.1.4.1.4	CLASS 4 – ADVISORY	
3.3.5.1.5	6.1.3.3.1.5	SERVICE REQUESTS	
3.3.5.1.6	6.1.3.3.1.6	ANCILLARY DATA	
3.3.5.1.7	6.1.3.3.1.7	FILE TRANSFER	
3.3.5.1.8	6.1.3.3.1.8	LOW RATE TELEMETRY	
	6.1.3.3.1.9	DEFINED MODE CODES	
3.3.5.1.10	6.1.3.3.1.10	IMPLEMENTED MODE CODES	
3.3.5.1.11	6.1.3.3.1.11	UNIMPLEMENTED/UNDEFINED MODE CODES	
3.3.5.1.12	6.1.3.3.1.12	ILLEGAL COMMANDS	
	6.1.3.3.2	MIL-STD-1553B LOW RATE DATA LINK (LRDL) INTERFACE CHARACTERISTICS	
	6.1.3.3.2.1	LRDL REMOTE TERMINAL ASSIGNMENT	
	6.1.3.3.2.1.1	LRDL CONNECTOR/PIN ASSIGNMENTS	

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	6.1.3.3.2.1.2	MIL–STD–1553B BUS A CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.2.A	6.1.3.3.2.1.2.A	MIL–STD–1553B BUS A CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.2.B	6.1.3.3.2.1.2.B	MIL–STD–1553B BUS A CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.2.C	6.1.3.3.2.1.2.C	MIL–STD–1553B BUS A CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.2.D	6.1.3.3.2.1.2.D	MIL–STD–1553B BUS A CONNECTOR/PIN ASSIGNMENT	
	6.1.3.3.2.1.3	MIL–STD–1553B BUS B CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.3.A	6.1.3.3.2.1.3.A	MIL–STD–1553B BUS B CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.3.B	6.1.3.3.2.1.3.B	MIL–STD–1553B BUS B CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.3.C	6.1.3.3.2.1.3.C	MIL–STD–1553B BUS B CONNECTOR/PIN ASSIGNMENT	
3.3.5.2.1.3.D	6.1.3.3.2.1.3.D	MIL–STD–1553B BUS B CONNECTOR/PIN ASSIGNMENT	
	6.1.3.3.2.2	LRDL SIGNAL CHARACTERISTICS	

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3.3.5.2.2	6.1.3.3.2.2.A	LRDL SIGNAL CHARACTERISTICS	
3.3.5.2.2	6.1.3.3.2.2.B	LRDL SIGNAL CHARACTERISTICS	
3.3.5.2.3	6.1.3.3.2.3	LRDL CABLING	
	6.1.3.4	MEDIUM RATE DATA LINK (MRDL)	
3.3.6.1	6.1.3.4.1	MRDL PROTOCOL	
3.3.6.1.1	6.1.3.4.1.1	HRF RACK PROTOCOLS ON THE MRDL	
	6.1.3.4.1.2	MRDL ADDRESS	
3.3.6.1.2	6.1.3.4.1.2.A	MRDL ADDRESS	
3.3.6.1.2	6.1.3.4.1.2.B	MRDL ADDRESS	
	6.1.3.4.1.3	ISPR MRDL CONNECTIVITY	
3.3.6.1.3.A	6.1.3.4.1.3.A	ISPR MRDL CONNECTIVITY	
3.3.6.1.3.B	6.1.3.4.1.3.B	ISPR MRDL CONNECTIVITY	
3.3.6.1.3.C	6.1.3.4.1.3.C	ISPR MRDL CONNECTIVITY	
3.3.6.1.3.D	6.1.3.4.1.3.D	ISPR MRDL CONNECTIVITY	
	6.1.3.4.1.4	MRDL CONNECTOR/PIN ASSIGNMENTS AND WIRE REQUIREMENTS	
3.3.6.1.4.A	6.1.3.4.1.4.A	MRDL CONNECTOR/PIN ASSIGNMENTS AND WIRE REQUIREMENTS	
3.3.6.1.4.B	6.1.3.4.1.4.B	MRDL CONNECTOR/PIN ASSIGNMENTS AND WIRE REQUIREMENTS	
3.3.6.1.4.C	6.1.3.4.1.4.C	MRDL CONNECTOR/PIN ASSIGNMENTS AND WIRE REQUIREMENTS	

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3.3.6.1.4.D	6.1.3.4.1.4.D	MRDL CONNECTOR/PIN ASSIGNMENTS AND WIRE REQUIREMENTS	
3.3.6.1.5	6.1.3.4.1.5	MRDL SIGNAL CHARACTERISTICS	
	6.1.3.4.1.6	MRDL CABLE CHARACTERISTICS	
3.3.6.1.6.1	6.1.3.4.1.6.1	INSERTION LOSS	
3.3.6.1.6.2	6.1.3.4.1.6.2	DIFFERENTIAL CHARACTERISTIC IMPEDANCE	
3.3.6.1.6.3	6.1.3.4.1.6.3	MEDIUM TIMING JITTER	
	6.1.3.5	HIGH RATE DATA LINK (HRDL)	
3.3.7.1	6.1.3.5.1	PAYLOAD TO HIGH RATE FRAME MULTIPLEXER (HRFM) PROTOCOLS	
	6.1.3.5.2	HRDL INTERFACE CHARACTERISTICS	
3.3.7.2.1	6.1.3.5.2.1	PHYSICAL SIGNALING	
3.3.7.2.2	6.1.3.5.2.2	ENCODING	
3.3.7.2.3	6.1.3.5.2.3	SYMBOLS USED IN TESTING	
	6.1.3.5.3	HRF RACK HRDL OPTICAL POWER	
	6.1.3.5.3.1	HRF RACK HRDL TRANSMITTED OPTICAL POWER	
3.3.7.3.1	6.1.3.5.3.1.A	HRF RACK HRDL TRANSMITTED OPTICAL POWER	

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3.3.7.3.1	6.1.3.5.3.1.B	HRF RACK HRDL TRANSMITTED OPTICAL POWER	
	6.1.3.5.3.2	HRF RACK HRDL RECEIVED OPTICAL POWER	
3.3.7.3.2	6.1.3.5.3.2.A	HRF RACK HRDL RECEIVED OPTICAL POWER	
3.3.7.3.2	6.1.3.5.3.2.B	HRF RACK HRDL RECEIVED OPTICAL POWER	
3.3.7.4	6.1.3.5.4	HRDL FIBER OPTIC CABLE	
3.3.7.5	6.1.3.5.5	HRDL FIBER OPTIC CABLE BEND RADIUS	
	6.1.3.5.6	HRDL CONNECTORS AND FIBER	
3.3.7.6.A	6.1.3.5.6.A	HRDL CONNECTORS AND FIBER	
3.3.7.6.B	6.1.3.5.6.B	HRDL CONNECTORS AND FIBER	
3.3.7.6.C	6.1.3.5.6.C	HRDL CONNECTORS AND FIBER	
3.3.7.6.D	6.1.3.5.6.D	HRDL CONNECTORS AND FIBER	
	6.1.3.5.7	PAYLOAD LAPTOP	
3.3.8.1.A	6.1.3.5.7.A	PAYLOAD LAPTOP	
3.3.8.1.B	6.1.3.5.7.B	PAYLOAD	
3.3.8.1.C	6.1.3.5.7.C	PAYLOAD LAPTOP	
3.3.8.1.D	6.1.3.5.7.D	PAYLOAD LAPTOP	
3.3.8.1.E	6.1.3.5.7.E	PAYLOAD LAPTOP	
3.3.8.1.F	6.1.3.5.7.F	PAYLOAD LAPTOP	
3.3.8.1.G	6.1.3.5.7.G	PAYLOAD LAPTOP	
3.3.8.1.H	6.1.3.5.7.H	PAYLOAD LAPTOP	

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	6.1.3.5.7	PCS	
3.3.8.2.A	6.1.3.5.7.A	PCS	
3.3.8.2.B	6.1.3.5.7.B	PCS	
3.3.8.2.C	6.1.3.5.7.C	PCS	
	6.1.3.6	MAINTENANCE SWITCH, SMOKE DETECTOR, SMOKE INDICATOR, AND HRF RACK FAN INTERFACES	
3.3.10.1	6.1.3.6.1	MAINTENANCE SWITCH INTERFACES	
	6.1.3.6.2	SMOKE DETECTOR INTERFACES	
3.3.10.2.1	6.1.3.6.2.1	ANALOG INTERFACE CHARACTERISTICS	
3.3.10.2.2	6.1.3.6.2.2	DISCRETE COMMAND BUILT-IN-TEST INTERFACE CHARACTERISTICS	
3.3.10.2.3	6.1.3.6.2.3	SMOKE INDICATOR ELECTRICAL INTERFACES	
3.3.10.2.4	6.1.3.6.2.4	FAN VENTILATION STATUS ELECTRICAL INTERFACES	
	6.1.3.6.3	HRF RACK POWER REMOVAL SWITCH/FIRE DETECTION SUPPORT INTERFACE CONNECTOR	
3.3.10.3.A	6.1.3.6.3.A	HRF RACK POWER REMOVAL SWITCH/FIRE DETECTION SUPPORT INTERFACE CONNECTOR	

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3.3.10.3.B	6.1.3.6.3.B	HRF RACK POWER REMOVAL SWITCH/FIRE DETECTION SUPPORT INTERFACE CONNECTOR	
3.3.10.3.C	6.1.3.6.3.C	HRF RACK POWER REMOVAL SWITCH/FIRE DETECTION SUPPORT INTERFACE CONNECTOR	
	6.1.4	PAYLOAD NTSC VIDEO INTERFACE REQUIREMENTS	
	6.1.4.1	PAYLOAD NTSC VIDEO CHARACTERISTICS	
3.4.1.1.A	6.1.4.1.A	PAYLOAD NTSC VIDEO CHARACTERISTICS	
3.4.1.1.B	6.1.4.1.B	PAYLOAD NTSC VIDEO CHARACTERISTICS	
3.4.1.1.C	6.1.4.1.C	PAYLOAD NTSC VIDEO CHARACTERISTICS	
	6.1.4.2	NTSC FIBER OPTIC VIDEO	
	6.1.4.2.1	PULSE FREQUENCY MODULATION NTSC FIBER OPTIC VIDEO CHARACTERISTICS	
3.4.1.2.1.A	6.1.4.2.1.A	PULSE FREQUENCY MODULATION NTSC FIBER OPTIC VIDEO CHARACTERISTICS	
3.4.1.2.1.B	6.1.4.2.1.B	PULSE FREQUENCY MODULATION NTSC FIBER OPTIC VIDEO CHARACTERISTICS	

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3.4.1.2.2	6.1.4.2.2	HRF RACK NTSC PFM VIDEO TRANSMITTED OPTICAL POWER	
3.4.1.2.3]	6.1.4.2.3	HRF RACK NTSC PFM VIDEO AND SYNC SIGNAL RECEIVED OPTICAL POWER	
3.4.1.2.4	6.1.4.2.4	FIBER OPTIC CABLE CHARACTERISTICS	
3.4.1.2.5	6.1.4.2.5	PFM NTSC VIDEO FIBER OPTIC CABLE BEND RADIUS	
	6.1.4.2.6	PFM NTSC OPTICAL CONNECTOR/PIN ASSIGNMENTS	
3.4.1.2.7.A	6.1.4.2.6.A	PFM NTSC OPTICAL CONNECTOR/PIN ASSIGNMENTS	
3.4.1.2.7.B	6.1.4.2.6.B	PFM NTSC OPTICAL CONNECTOR/PIN ASSIGNMENTS	
3.4.1.2.7.C	6.1.4.2.6.C	PFM NTSC OPTICAL CONNECTOR/PIN ASSIGNMENTS	
	6.1.4.3	NTSC ELECTRICAL VIDEO INTERFACES	
	6.1.4.3.1	NTSC ELECTRICAL VIDEO CHARACTERISTICS	
	6.1.4.4	NTSC ELECTRICAL CONNECTOR/PIN ASSIGNMENTS	
3.4.1.4.A	6.1.4.4.A	NTSC ELECTRICAL CONNECTOR/PIN ASSIGNMENTS	

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3.4.1.4.B	6.1.4.4.B	NTSC ELECTRICAL CONNECTOR/PIN ASSIGNMENTS	
3.4.1.4.C	6.1.4.4.C	NTSC ELECTRICAL CONNECTOR/PIN ASSIGNMENTS	
	6.1.5	THERMAL CONTROL INTERFACE REQUIREMENTS	
3.5.1.1.A	6.1.5.1	MTL PHYSICAL INTERFACE	
	6.1.5.2	INTERNAL THERMAL CONTROL SYSTEM (ITCS) FLUID USE AND CHARGING	
3.5.1.2.A	6.1.5.2.A	ITCS Fluid Use	
3.5.1.2.B	6.1.5.2.B	HRF Rack Charging	
3.5.1.3.A	6.1.5.3	ITCS PRESSURE DROP	
3.5.1.4.A	6.1.5.4	MTL COOLANT FLOW RATE	
3.5.1.5.A	6.1.5.5	MTL COOLANT SUPPLY TEMPERATURE	
	6.1.5.6	MTL COOLANT RETURN TEMPERATURE	
3.5.1.6.A as modified by approved PIRN 57200NA0001	6.1.5.6.A	MTL COOLANT RETURN TEMPERATURE	
3.5.1.6.B as modified by approved PIRN 57200NA0001	6.1.5.6.B	MTL COOLANT RETURN TEMPERATURE	
3.5.1.6.C	6.1.5.6.C	MTL COOLANT RETURN TEMPERATURE	
3.5.1.7.A	6.1.5.7	MTL COOLANT MAXIMUM DESIGN PRESSURE	
3.5.1.8	6.1.5.8	FAIL SAFE DESIGN	

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	6.1.5.9	LEAKAGE	
3.5.1.10	6.1.5.10	QUICK-DISCONNECT AIR INCLUSION	
3.5.1.11	6.1.5.11	RACK FRONT SURFACE TEMPERATURE	
	6.1.5.12	CABIN AIR HEAT LEAK	
3.5.1.15	6.1.5.13	CONTROL SYSTEM TIME CONSTANT	
3.5.1.16	6.1.5.15	PAYLOAD COOLANT QUANTITY	
3.5.1.17	6.1.5.16	PAYLOAD GAS INCLUSION	
	6.1.6	VACUUM SYSTEM REQUIREMENTS	
	6.1.6.1	VACUUM EXHAUST SYSTEM REQUIREMENTS	
3.6.1.1	6.1.6.1.1	VES PHYSICAL INTERFACE	
3.6.1.2.B	6.1.6.1.2	INPUT PRESSURE LIMIT	
	6.1.6.2	VACUUM RESOURCE SYSTEM REQUIREMENTS	
3.6.2.1	6.1.6.2.1	VRS PHYSICAL INTERFACE	
3.6.2.2.B	6.1.6.2.2	INPUT PRESSURE LIMIT	
	6.1.7	PRESSURIZED GASES INTERFACE REQUIREMENTS	
3.7.1.2	6.1.7.1	NITROGEN INTERFACE MDP	
3.7.1.3	6.1.7.2	NITROGEN INTERFACE TEMPERATURE	
	6.1.7.3	NITROGEN LEAKAGE	
3.7.1.5	6.1.7.4	NITROGEN INTERFACE CONNECTION	
3.8.2	6.1.8	FLUID SYSTEM SERVICER	

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	6.1.9	ENVIRONMENT INTERFACE REQUIREMENTS	
	6.1.9.1	ATMOSPHERE REQUIREMENTS	
3.9.1.1	6.1.9.1.1	PRESSURE	
3.9.1.2	6.1.9.1.2	TEMPERATURE	
3.9.1.3	6.1.9.1.3	HUMIDITY	
	6.1.9.2	INTEGRATED RACK USE OF CABIN ATMOSPHERE	
3.9.2.1.A	6.1.9.2.1	ACTIVE AIR EXCHANGE	
3.9.2.2	6.1.9.2.2	OXYGEN CONSUMPTION	
3.9.2.3	6.1.9.2.3	CHEMICAL RELEASES	
	6.1.9.3	IONIZING RADIATION REQUIREMENTS	
3.9.3.1	6.1.9.3.1	HRF RACK CONTAINED OR GENERATED IONIZING RADIATION	
	6.1.9.3.2	IONIZING RADIATION DOSE	
3.9.3.3	6.1.9.3.3	SINGLE EVENT EFFECT (SEE) IONIZING RADIATION	
3.9.3.4	6.1.9.3.4	ADDITIONAL ENVIRONMENTAL CONDITIONS	
	6.1.10	FIRE PROTECTION INTERFACE REQUIREMENTS	
3.10.1	6.1.10.1	FIRE PREVENTION	
	6.1.10.2	PAYLOAD MONITORING AND DETECTION REQUIREMENTS	
	6.1.10.2.1	SMOKE DETECTION	
	6.1.10.2.1.1	SMOKE DETECTOR	
3.10.2.1.1.A	6.1.10.2.1.1.A	SMOKE DETECTOR	

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3.10.1.1.B	6.1.10.2.1.1.B	SMOKE DETECTOR	
3.10.2.1.2	6.1.10.2.1.2	FORCED AIR CIRCULATION INDICATION	
	6.1.10.2.1.3	FIRE DETECTION INDICATOR	
3.10.2.1.3.A	6.1.10.2.1.3.A	FIRE DETECTION INDICATOR	
3.10.2.1.3.B	6.1.10.2.1.3.B	FIRE DETECTION INDICATOR	
	6.1.10.3	FIRE SUPPRESSION	
	6.1.10.3.1	PORTABLE FIRE EXTINGUISHER	
3.10.3.1.A	6.1.10.3.1.A	PORTABLE FIRE EXTINGUISHER	
3.10.3.1.B	6.1.10.3.1.B	PORTABLE FIRE EXTINGUISHER	
3.10.3.2	6.1.10.3.2	FIRE SUPPRESSION ACCESS PORT ACCESSIBILITY	
3.10.3.2	6.1.10.3.3	FIRE SUPPRESSANT DISTRIBUTION	
	6.1.10.4	LABELING	
3.10.4.A	6.1.10.4.A	LABELING	
3.10.4.B	6.1.10.4.B	LABELING	
	6.1.11	MATERIALS AND PARTS INTERFACE REQUIREMENTS	
3.11.1	6.1.11.1	MATERIALS AND PARTS USE AND SELECTION	
3.11.1.1	6.1.11.1.1	COMMERCIAL PARTS	
	6.1.11.2	FLUIDS	
3.11.2.A	6.1.11.2.A	FLUIDS	
3.11.2.B	6.1.11.2.B	FLUIDS	
3.11.2.C	6.1.11.2.C	FLUIDS	
3.11.3	6.1.11.3	CLEANLINESS	

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3.11.4	6.1.11.4	FUNGUS RESISTANT MATERIAL	
	6.2	HRF RACK DEPENDENT INSTRUMENT INTERFACE AND ISS DESIGN REQUIREMENTS	
	6.2.1	STRUCTURAL/MECHANICAL	
3.1.1.5.A	6.2.1.1	SAFETY CRITICAL STRUCTURES	
	6.2.1.2	DYNAMIC PRESSURE	
Generalization of 3.1.1.2.B	6.2.1.2.A	DYNAMIC PRESSURE	
3.1.1.4.B	6.2.1.2.B	DYNAMIC PRESSURE	
3.1.1.4.K	6.2.1.2.C	DYNAMIC PRESSURE	
	6.2.1.3	HRF RACK DEPENDENT INSTRUMENT LOADS	
	6.2.1.3.1	GENERAL	
3.1.1.3.A	6.2.1.3.1.A	GENERAL	
3.1.1.3.B	6.2.1.3.1.B	GENERAL	
3.1.1.3.D	6.2.1.3.1.C	GENERAL	
	6.2.1.3.2	HRF RACK MOUNTED SIR DRAWER INSTRUMENTS	
3.1.1.3.A	6.2.1.3.2.A	HRF RACK MOUNTED SIR DRAWER INSTRUMENTS	
3.1.1.3.E	6.2.1.3.2.B	HRF RACK MOUNTED SIR DRAWER INSTRUMENTS	
3.1.1.3.F	6.2.1.3.2.C	HRF RACK MOUNTED SIR DRAWER INSTRUMENTS	
3.1.1.4.D	6.2.1.3.2.D	HRF RACK MOUNTED SIR DRAWER INSTRUMENTS	

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	6.2.1.4	HRF RACK STRUCTURAL INTERFACE REQUIREMENTS	
S683-34510, REV. A	6.2.1.4.1	SIR DRAWER STRUCTURAL/ MECHANICAL INTERFACES	
S683-34510, REV. A	6.2.1.4.1.2	DIMENSIONAL TOLERANCES	
	6.2.1.4.1.3	HRF SIR DRAWER MAXIMUM DIMENSIONAL ENVELOPES	
S683-34510, REV. A	6.2.1.4.1.3.1	HRF SIR DRAWER ENCLOSURES	
	6.2.1.4.1.3.2	HRF SIR DRAWER FRONT PANEL PERMANENT PROTRUSIONS	
S683-34510, REV. A	6.2.1.4.1.3.2.A	HRF SIR DRAWER FRONT PANEL PERMANENT PROTRUSIONS	
S683-34510, REV. A	6.2.1.4.1.3.2.B	HRF SIR DRAWER FRONT PANEL PERMANENT PROTRUSIONS	
S683-34510, REV. A	6.2.1.4.1.3.2.C	HRF SIR DRAWER FRONT PANEL PERMANENT PROTRUSIONS	
S683-34510, REV. A	6.2.1.4.1.4	HRF RACK MOUNTED SIR DRAWER CENTER OF GRAVITY CONSTRAINTS	
	6.2.1.4.2	HRF RACK SEAT TRACK INTERFACES	
	6.2.1.5	MICROGRAVITY	
	6.2.1.5.1	QUASI-STEADY REQUIREMENTS	
	6.2.1.5.2	VIBRATORY REQUIREMENTS	
	6.2.1.5.3	TRANSIENT REQUIREMENTS	

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	6.2.2	ELECTRICAL POWER REQUIREMENTS	
	6.2.2.1	HRF RACK POWER OUTPUT CONNECTORS	
S683-34510, REV. A	6.2.2.1.1	SIR DRAWER POWER CONNECTORS	
S683-34510, REV. A	6.2.2.1.2	RACK CONNECTOR PANEL J1 POWER CONNECTOR	
	6.2.2.2	VOLTAGE CHARACTERISTICS	
S683-34510, REV. A	6.2.2.2.1	STEADY-STATE OPERATING VOLTAGE ENVELOPE	
S683-34510, REV. A	6.2.2.2.2	TRANSIENT OPERATING VOLTAGE ENVELOPE	
	6.2.2.2.3	RIPPLE VOLTAGE/NOISE CHARACTERISTICS	
S683-34510, REV. A	6.2.2.2.3.A	RIPPLE VOLTAGE/NOISE CHARACTERISTICS	
S683-34510, REV. A	6.2.2.2.3.B	RIPPLE VOLTAGE/NOISE CHARACTERISTICS	
S683-34510, REV. A	6.2.2.3	MAXIMUM CURRENT LIMIT	
S683-34510, REV. A	6.2.2.4.	REVERSE CURRENT	
S683-34510, REV. A	6.2.2.5	REVERSE ENERGY	
S683-34510, REV. A	6.2.2.6	CAPACITIVE LOADS	
	6.2.2.7	ELECTRICAL POWER CONSUMER CONSTRAINTS	
	6.2.2.7.1	WIRE DERATING	
Modified from SSP 57000C, paragraph 3.2.3.1.B	6.2.2.7.1.A	WIRE DERATING	
DERIVED	6.2.2.7.1.B	WIRE DERATING	

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	6.2.2.7.2	EXCLUSIVE POWER FEEDS 3.2.3.2.C	
3.2.3.3	6.2.2.7.3	LOSS OF POWER	
3.2.4	6.2.2.8	ELECTROMAGNETIC COMPATIBILITY	
3.2.4.1	6.2.2.8.1	ELECTRICAL GROUNDING	
3.2.4.2	6.2.2.8.2	ELECTRICAL BONDING	
3.2.4.3	6.2.2.8.3	CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS	
3.2.4.4	6.2.2.8.4	ELECTROMAGNETIC INTERFERENCE	
3.2.4.5	6.2.2.9	ELECTROSTATIC DISCHARGE	
3.2.4.6	6.2.2.10	ALTERNATING CURRENT (AC) MAGNETIC FIELDS	
3.2.4.7	6.2.2.11	DIRECT CURRENT (DC) MAGNETIC FIELDS	
3.2.4.8	6.2.2.12	CORONA	
3.2.4.10	6.2.2.13	EMI SUSCEPTIBILITY FOR SAFETY-CRITICAL CIRCUITS	
3.2.5.1.2	6.2.2.14	SAFETY REQUIREMENTS	
	6.2.2.14.1	HRF RACK DEPENDENT INSTRUMENTS ELECTRICAL SAFETY	
3.2.5.1.1	6.2.2.14.1.1	MATING/DEMATING OF POWERED CONNECTORS	
3.2.5.1.2	6.2.2.14.1.2	SAFETY-CRITICAL CIRCUITS REDUNDANCY	
	6.2.2.15	POWER SWITCHES/CONTROLS	
3.2.5.3.A	6.2.2.15.A	POWER SWITCHES/CONTROLS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.5.3.B	6.2.2.15.B	POWER SWITCHES/CONTROLS	
3.2.5.3.C	6.2.2.15.C	POWER SWITCHES/CONTROLS	
	6.2.2.16	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.A	6.2.2.16.A	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.B	6.2.2.16.B	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.C	6.2.2.16.C	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.D	6.2.2.16.D	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.5.4.E	6.2.2.16.E	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.F	6.2.2.16.F	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.G	6.2.2.16.G	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
	6.2.2.17	PORTABLE EQUIPMENT/POWER CORDS	
3.2.5.5.A	6.2.2.17.A	PORTABLE EQUIPMENT/POWER CORDS	
3.2.5.5.B	6.2.2.17.B	PORTABLE EQUIPMENT/POWER CORDS	
	6.2.3	COMMAND AND DATA HANDLING INTERFACE REQUIREMENTS	
	6.2.3.1	HRF RACK DATA CONNECTORS	
S683-34510, REV. A	6.2.3.1.1	SIR DRAWER DATA CONNECTORS	
S683-34510, REV. A	6.2.3.1.2	HRF RACK CONNECTOR PANEL J2 DATA CONNECTOR	
S683-34510, REV. A	6.2.3.2	HRF ETHERNET INTERFACES	
S683-34510, REV. A	6.2.3.3	HRF TIA/EIA-422 INTERFACES	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
S683-34510, REV. A	6.2.3.4	HRF BI-DIRECTIONAL DISCRETES INTERFACES	
S683-34510, REV. A	6.2.3.5	HRF ANALOG INTERFACES	
	6.2.3.6	WORD/BYTE NOTATIONS, TYPES AND DATA TRANSMISSIONS	
3.3.2.1	6.2.3.6.1	WORD/BYTE NOTATIONS	
3.3.2.2	6.2.3.6.2	DATA TYPES	
	6.2.3.7	MEDIUM RATE DATA LINK (MRDL)	
3.3.2.3.B	6.2.3.7.1	DATA TRANSMISSIONS	
	6.2.3.7.2	CCSDS DATA	
3.3.4.1.A	6.2.3.7.2.A	CCSDS DATA	
3.3.4.1.B	6.2.3.7.2.B	CCSDS DATA	
3.3.4.1.C	6.2.3.7.2.C	CCSDS DATA	
3.3.4.1.1	6.2.3.7.2.1	CCSDS DATA PACKETS	
3.3.4.1.1.1	6.2.3.7.2.1.1	CCSDS PRIMARY HEADER	
	6.2.3.7.2.1.2	CCSDS SECONDARY HEADER	
3.3.4.1.1.2.A	6.2.3.7.2.1.2.A	CCSDS SECONDARY HEADER	
3.3.4.1.1.2.B	6.2.3.7.2.1.2.B	CCSDS SECONDARY HEADER	
3.3.4.1.2	6.2.3.7.2.2	CCSDS DATA FIELD	
3.3.4.1.4	6.2.3.7.2.3	CCSDS APPLICATION PROCESS IDENTIFICATION FIELD	
	6.2.3.8	ISS C&DH SERVICES THROUGH THE HRF RACK INTERFACE CONTROLLER (RIC)	
DERIVED	6.2.3.8.1	SERVICE REQUESTS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
	6.2.3.9	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.2.3.9.A	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.2.3.9.B	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.2.3.9.C	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.2.3.9.D	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.2.3.9.E	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
	6.2.4	PAYLOAD NTSC VIDEO INTERFACE REQUIREMENTS	
	6.2.4.1	HRF RACK VIDEO CONNECTORS	
S683-34510, REV. A	6.2.4.1.1	SIR DRAWER VIDEO INTERFACE	
S683-34510, REV. A	6.2.4.1.2	RACK CONNECTOR PANEL INTERFACE	
S683-34510, REV. A	6.2.4.2	HRF RACK VIDEO INTERFACE CHARACTERISTICS	
	6.2.5	THERMAL CONTROL INTERFACE REQUIREMENTS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
S683-34510, REV. A	6.2.5.1	HRF RACK PROVIDED ITCS MODERATE TEMPERATURE LOOP (MTL) INTERFACE	
	6.2.5.2	ITCS FLUID USE AND CHARGING	
3.5.1.2.A	6.2.5.2.A	ITCS FLUID USE	
3.5.1.2.B	6.2.5.2.B	RACK DEPENDENT INSTRUMENT CHARGING	
S683-34510, REV. A	6.2.5.3	MAXIMUM HEAT LOAD	
3.5.1.7.A	6.2.5.4	COOLANT MAXIMUM DESIGN PRESSURE	
3.5.1.8	6.2.5.5	FAIL SAFE DESIGN	
	6.2.5.6	LEAKAGE	
3.5.1.10	6.2.5.7	QUICK-DISCONNECT AIR INCLUSION	
3.5.1.11	6.2.5.8	RACK FRONT SURFACE TEMPERATURE	
	6.2.5.9	CABIN AIR HEAT LEAK	
	6.2.5.10	CABIN AIR COOLING	
	6.2.5.11	PAYLOAD COOLANT QUANTITY	
HRF Engineering Directive ED-003	6.2.5.12	HRF RACK MOUNTED SIR DRAWER COOLING FANS	
	6.2.6	VACUUM SYSTEM REQUIREMENTS	
S683-34510, REV. A	6.2.6.1	HRF RACK VACUUM INTERFACE CONNECTORS	
	6.2.6.2	VES REQUIREMENTS	
	6.2.6.2.1	INPUT PRESSURE LIMIT	
3.6.1.2.A	6.2.6.2.1.A	INPUT PRESSURE LIMIT	
3.6.1.2.B	6.2.6.2.1.B	INPUT PRESSURE LIMIT	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.6.1.3	6.2.6.2.2	INPUT TEMPERATURE LIMIT	
3.6.1.4	6.2.6.2.3	INPUT DEWPOINT LIMIT	
	6.2.6.2.4	ACCEPTABLE EXHAUST GASES	
3.6.1.5.A	6.2.6.2.4.A	ACCEPTABLE EXHAUST GASES	
3.6.1.5.B	6.2.6.2.4.B	ACCEPTABLE EXHAUST GASES	
3.6.1.5.2	6.2.6.2.5	EXTERNAL CONTAMINATION CONTROL	
	6.2.6.2.6	INCOMPATIBLE GASES	
3.6.1.5.3.A	6.2.6.2.6.A	INCOMPATIBLE GASES	
3.6.1.5.3.B	6.2.6.2.6.B	INCOMPATIBLE GASES	
	6.2.6.3	VACUUM RESOURCE SYSTEM REQUIREMENTS	
	6.2.6.3.1	INPUT PRESSURE LIMIT	
3.6.2.2.A	6.2.6.3.1.A	INPUT PRESSURE LIMIT	
3.6.2.2.B	6.2.6.3.1.B	INPUT PRESSURE LIMIT	
3.6.2.3	6.2.6.3.2	VRS THROUGH-PUT LIMIT	
	6.2.6.3.3	ACCEPTABLE GASES	
	6.2.7	PRESSURIZED GAS INTERFACE REQUIREMENTS	
	6.2.7.1	NITROGEN INTERFACE REQUIREMENTS	
S683-34510, REV. A	6.2.7.1.1	HRF RACK NITROGEN INTEFACE CONNECTORS	
3.7.1.1	6.2.7.1.2	NITROGEN INTERFACE CONTROL	
3.7.1.2	6.2.7.1.3	NITROGEN INTERFACE MDP	
3.7.1.3	6.2.7.1.4	NITROGEN INTERFACE TEMPERATURE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
	6.2.7.1.5	NITROGEN LEAKAGE	
3.7.5	6.2.7.2	PRESSURIZED GAS BOTTLES	
3.7.6	6.2.7.3	MANUAL VALVES	
	6.2.8	PAYLOAD SUPPORT SERVICES INTERFACES REQUIREMENTS	
	6.2.8.1	POTABLE WATER	
3.8.1.1, Table 3.1.1.6.1 item V	6.2.8.1.1	ISS POTABLE WATER INTERFACE CONNECTION	
3.8.1.2	6.2.8.1.2	POTABLE WATER INTERFACE PRESSURE	
	6.2.8.1.3	POTABLE WATER USE	
3.8.1.3.A	6.2.8.1.3.A	POTABLE WATER USE	
3.8.1.3.B	6.2.8.1.3.B	POTABLE WATER USE	
3.8.2	6.2.8.2	FLUID SYSTEM SERVICER	
	6.2.9	ENVIRONMENT INTERFACE REQUIREMENTS	
	6.2.9.1	ATMOSPHERE REQUIREMENTS	
3.9.1.1	6.2.9.1.1	PRESSURE	
3.9.1.2	6.2.9.1.2	TEMPERATURE	
3.9.1.3	6.2.9.1.3	HUMIDITY	
	6.2.9.2	INSTRUMENT USE OF CABIN ATMOSPHERE	
	6.2.9.2.1	ACTIVE AIR EXCHANGE	
3.9.2.1.A	6.2.9.2.1.A	ACTIVE AIR EXCHANGE	
3.9.2.1.B	6.2.9.2.1.B	ACTIVE AIR EXCHANGE	
	6.2.9.2.2	OXYGEN CONSUMPTION	
3.9.2.3	6.2.9.2.3	CHEMICAL RELEASES	
	6.2.9.3	IONIZING RADIATION REQUIREMENTS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.9.3.1	6.2.9.3.1	INSTRUMENT CONTAINED OR GENERATED IONIZING RADIATION	
	6.2.9.3.2	IONIZING RADIATION DOSE	
3.9.3.3	6.2.9.3.3	SINGLE EVENT EFFECT (SEE) IONIZING RADIATION	
	6.2.9.3.4	ADDITIONAL ENVIRONMENTAL CONDITIONS	
	6.2.10	FIRE PROTECTION INTERFACE REQUIREMENTS	
3.10.1	6.2.10.1	FIRE PREVENTION	
	6.2.10.2	PORTABLE FIRE EXTINGUISHER	
3.10.3.1.A	6.2.10.2.A	PORTABLE FIRE EXTINGUISHER	
3.10.3.1.B	6.2.10.2.B	PORTABLE FIRE EXTINGUISHER	
3.10.3.2	6.2.10.3	FIRE SUPPRESSION ACCESS PORT ACCESSIBILITY	
3.10.3.2	6.2.10.4	FIRE SUPPRESSANT DISTRIBUTION	
3.10.4.A	6.2.10.5	LABELING	
	6.2.11	MATERIALS AND PARTS INTERFACE REQUIREMENTS	
3.11.1	6.2.11.1	MATERIALS AND PARTS USE AND SELECTION	
3.11.1.1	6.2.11.2	COMMERCIAL PARTS	
	6.2.11.3	FLUIDS	
3.11.2.A	6.2.11.3.A	FLUIDS	
3.11.2.B	6.2.11.3.B	FLUIDS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.11.2.C	6.2.11.3.C	FLUIDS	
3.11.3	6.2.11.4	CLEANLINESS	
3.11.4	6.2.11.5	FUNGUS RESISTANT MATERIAL	
	6.3	ISS DESIGN REQUIREMENTS FOR HRF RACK INDEPENDENT INSTRUMENTS	
	6.3.1	STRUCTURAL/MECHANICAL	
3.1.1.5.A	6.3.1.1	SAFETY CRITICAL STRUCTURES REQUIREMENTS	
	6.3.1.2	DYNAMIC PRESSURE REQUIREMENTS	
GENERALIZATION OF 3.1.1.2.B	6.3.1.2.A	DYNAMIC PRESSURE REQUIREMENTS	
3.1.1.4.B	6.3.1.2.B	DYNAMIC PRESSURE REQUIREMENTS	
3.1.1.4.K	6.3.1.2.C	DYNAMIC PRESSURE REQUIREMENTS	
	6.3.1.3	LOADS REQUIREMENTS	
GENERALIZATION OF 3.1.1.3	6.3.1.3.A	LOADS REQUIREMENTS	
3.1.1.3.B	6.3.1.3.B	LOADS REQUIREMENTS	
3.1.1.3.D	6.3.1.3.C	LOADS REQUIREMENTS	
	6.3.1.4	MICROGRAVITY	
	6.3.1.4.1	QUASI-STEADY REQUIREMENTS	
	6.3.1.4.2	VIBRATORY REQUIREMENTS	
	6.3.1.4.3	TRANSIENT REQUIREMENTS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
	6.3.2	ELECTRICAL DESIGN REQUIREMENTS	
	6.3.2.1	WIRE DERATING	
3.2.3.1.A	6.3.2.1.A	WIRE DERATING	
3.2.3.1.B	6.3.2.1.B	WIRE DERATING	
3.2.3.2.B	6.3.2.2	EXCLUSIVE POWER FEEDS	
3.2.3.3	6.3.2.3	LOSS OF POWER	
3.2.4	6.3.2.4	ELECTROMAGNETIC COMPATIBILITY	
3.2.4.1	6.3.2.4.1	ELECTRICAL GROUNDING	
3.2.4.2	6.3.2.4.2	ELECTRICAL BONDING	
3.2.4.3	6.3.2.4.3	CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS	
3.2.4.4	6.3.2.4.4	ELECTROMAGNETIC INTERFERENCE	
3.2.4.5	6.3.2.5	ELECTROSTATIC DISCHARGE	
3.2.4.6	6.3.2.6	ALTERNATING CURRENT (AC) MAGNETIC FIELDS	
3.2.4.7	6.3.2.7	DIRECT CURRENT (DC) MAGNETIC FIELDS	
3.2.4.8	6.3.2.8	CORONA	
3.2.4.10	6.3.2.9	EMI SUSCEPTIBILITY FOR SAFETY-CRITICAL CIRCUITS	
3.2.5.1.1	6.3.2.10	INSTRUMENT ELECTRICAL SAFETY	
3.2.5.1.1	6.3.2.10.1	MATING/DEMATING OF POWERED CONNECTORS	
3.2.5.1.2	6.3.2.10.2	SAFETY-CRITICAL CIRCUITS REDUNDANCY	
	6.3.2.10.3	POWER SWITCHES/CONTROLS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.5.3.A	6.3.2.10.3.A	POWER SWITCHES/CONTROLS	
3.2.5.3.B	6.3.2.10.3.B	POWER SWITCHES/CONTROLS	
3.2.5.3.C	6.3.2.10.3.C	POWER SWITCHES/CONTROLS	
	6.3.2.10.4	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.A	6.3.2.10.4.A	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.B	6.3.2.10.4.B	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.C	6.3.2.10.4.C	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.D	6.3.2.10.4.D	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.2.5.4.E	6.3.2.10.4.E	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.F	6.3.2.10.4.F	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
3.2.5.4.G	6.3.2.10.4.G	GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)/PORTABLE EQUIPMENT DC SOURCING VOLTAGE	
	6.3.2.10.5	PORTABLE EQUIPMENT/POWER CORDS	
3.2.5.5.A	6.3.2.10.5.A	PORTABLE EQUIPMENT/POWER CORDS	
3.2.5.5.B	6.3.2.10.5.B	PORTABLE EQUIPMENT/POWER CORDS	
	6.3.3	COMMAND AND DATA HANDLING REQUIREMENTS	
	6.3.3.1	WORD/BYTE NOTATIONS, TYPES AND DATA TRANSMISSIONS	
3.3.2.1	6.3.3.1.1	WORD/BYTE NOTATIONS	
3.3.2.2	6.3.3.1.2	DATA TYPES	
	6.3.3.2	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
DERIVED	6.3.3.2.A	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.3.3.2.B	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.3.3.2.C	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.3.3.2.D	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
DERIVED	6.3.3.2.E	ISS C&DH SERVICES THROUGH HRF COMMON SOFTWARE INTERFACE	
	6.3.4	THERMAL CONTROL REQUIREMENTS	
	6.3.4.1	ITCS FLUID USE AND CHARGING	
3.5.1.2.A	6.3.4.1.A	ITCS FLUID USE	
3.5.1.2.B	6.3.4.1.B	INSTRUMENT CHARGING	
	6.3.4.2	COOLANT MAXIMUM DESIGN PRESSURE	
3.5.1.7.A	6.3.4.2.A	MODERATE TEMPERATURE LOOP	
3.5.1.7.B	6.3.4.2.B	LOW TEMPERATURE LOOP	
3.5.1.7.C	6.3.4.2.C	MPLM TEMPERATURE LOOP	
3.5.1.8	6.3.4.3	FAIL SAFE DESIGN	
	6.3.4.4	LEAKAGE	
3.5.1.10	6.3.4.5	QUICK-DISCONNECT AIR INCLUSION	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
3.5.1.11	6.3.4.6	INSTRUMENT SURFACE TEMPERATURE	
	6.3.4.7	CABIN AIR HEAT LEAK	
3.5.1.13	6.3.4.8	CABIN AIR COOLING	
3.5.1.14.B	6.3.4.9	SIMULTANEOUS COOLING	
	6.3.4.10	INSTRUMENT COOLANT QUANTITY	
	6.3.4.11	INSTRUMENT GAS INCLUSION	
	6.3.5	VACUUM SYSTEM REQUIREMENTS	
	6.3.5.1	VACUUM EXHAUST SYSTEM REQUIREMENTS	
	6.3.5.1.1	INPUT PRESSURE LIMIT	
3.6.1.2.A	6.3.5.1.1.A	INPUT PRESSURE LIMIT	
3.6.1.2.B	6.3.5.1.1.B	INPUT PRESSURE LIMIT	
3.6.1.3	6.3.5.1.2	INPUT TEMPERATURE LIMIT	
3.6.1.4	6.3.5.1.3	INPUT DEWPOINT LIMIT	
	6.3.5.1.4	ACCEPTABLE EXHAUST GASES	
3.6.1.5.A	6.3.5.1.4.A	ACCEPTABLE EXHAUST GASES	
3.6.1.5.B	6.3.5.1.4.B	ACCEPTABLE EXHAUST GASES	
3.6.1.5.2	6.3.5.1.5	EXTERNAL CONTAMINATION CONTROL	
	6.3.5.1.6	INCOMPATIBLE GASES	
3.6.1.5.3.A	6.3.5.1.6.A		
3.6.1.5.3.B	6.3.5.1.6.B		
	6.3.5.2	VACUUM RESOURCE SYSTEM REQUIREMENTS	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
	6.3.5.2.1	INPUT PRESSURE LIMIT	
3.6.2.2.A	6.3.5.2.1.A	INPUT PRESSURE LIMIT	
3.6.2.2.B	6.3.5.2.1.B	INPUT PRESSURE LIMIT	
3.6.2.3	6.3.5.2.2	VRS THROUGH-PUT LIMIT	
	6.3.5.2.3	ACCEPTABLE GASES	
	6.3.6	PRESSURIZED GASES INTERFACE REQUIREMENTS	
	6.3.6.1	NITROGEN INTERFACE REQUIREMENTS	
3.7.1.1	6.3.6.1.1	NITROGEN FLOW CONTROL	
3.7.1.2	6.3.6.1.2	NITROGEN INTERFACE MDP	
3.7.1.3	6.3.6.1.3	NITROGEN INTERFACE TEMPERATURE	
	6.3.6.1.4	NITROGEN LEAKAGE	
	6.3.6.2	ARGON INTERFACE REQUIREMENTS	
3.7.2.1	6.3.6.2.1	ARGON FLOW CONTROL	
3.7.2.2	6.3.6.2.2	ARGON INTERFACE MDP	
3.7.2.3	6.3.6.2.3	ARGON INTERFACE TEMPERATURE	
	6.3.6.2.4	ARGON LEAKAGE	
	6.3.6.3	CARBON DIOXIDE INTERFACE REQUIREMENTS	
3.7.3.1	6.3.6.3.1	CARBON DIOXIDE FLOW CONTROL	
3.7.3.2	6.3.6.3.2	CARBON DIOXIDE INTERFACE MDP	
3.7.3.3	6.3.6.3.3	CARBON DIOXIDE INTERFACE TEMPERATURE	
	6.3.6.3.4	CARBON DIOXIDE LEAKAGE	

SSP 57000 Paragraph	LS-71000 Paragraph	LS-71000 Paragraph Title	VRDS Number
	6.3.6.4	HELIUM INTERFACE REQUIREMENTS	
3.7.4.1	6.3.6.4.1	HELIUM FLOW CONTROL	
3.7.4.2	6.3.6.4.2	HELIUM INTERFACE MDP	
3.7.4.3	6.3.6.4.3	HELIUM INTERFACE TEMPERATURE	
	6.3.6.4.4	HELIUM LEAKAGE	
3.7.5	6.3.6.5	PRESSURIZED GAS BOTTLES	
3.7.6	6.3.6.6	MANUAL VALVES	
	6.3.7	PAYLOAD SUPPORT SERVICES INTERFACES REQUIREMENTS	
	6.3.7.1	POTABLE WATER	
3.8.1.1, TABLE 3.1.1.6.1 ITEM V	6.3.7.1.1	POTABLE WATER INTERFACE CONNECTION	
3.8.1.2	6.3.7.1.2	POTABLE WATER INTERFACE PRESSURE	
	6.3.7.1.3	POTABLE WATER USE	
3.8.1.3.A	6.3.7.1.3.A	POTABLE WATER USE	
3.8.1.3.B	6.3.7.1.3.B	POTABLE WATER USE	
3.8.2	6.3.7.2	FLUID SYSTEM SERVICER	
	6.3.8	ENVIRONMENT INTERFACE REQUIREMENTS	
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